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Author:

U.S. Congress. House.

Title:

**Report of the Committee
on Coinage, Weights...**

Place:

Washington, D.C.

Date:

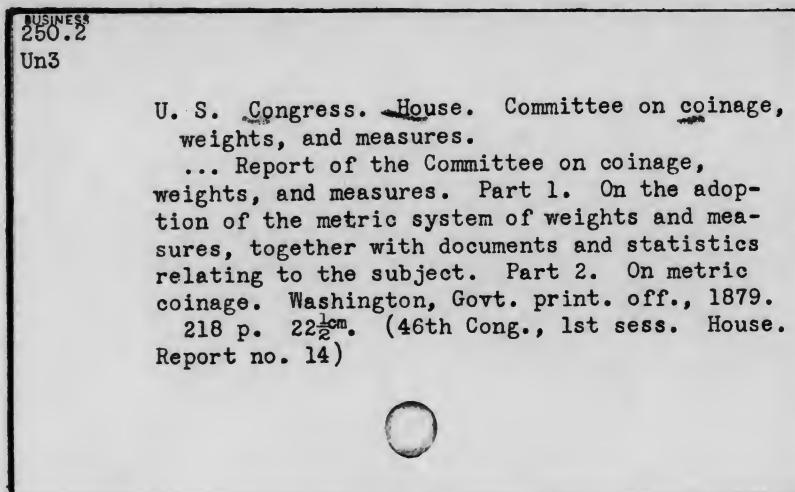
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U.S. CONGRESS. HOUSE. COMMITTEE ON
COINAGE, WEIGHTS, AND MEASURES.

REPORT. 46:1. 1879.

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46TH CONGRESS, } HOUSE OF REPRESENTATIVES. { REPORT
1st Session. } NO. 14.

REPORT

OF

THE COMMITTEE

ON

COINAGE, WEIGHTS, AND MEASURES.

PART 1.

ON THE ADOPTION OF THE METRIC SYSTEM OF
WEIGHTS AND MEASURES,

TOGETHER WITH

DOCUMENTS AND STATISTICS RELATING TO THE SUBJECT.

PART 2.

ON METRIC COINAGE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1879.

Business

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P R E F A C E.

On the 27th day of May, 1878, Hons. Levi Maish, H. L. Muldrow, and R. M. Knapp, of the Committee of the House on Coinage, Weights, and Measures, were appointed by the chairman, Mr. Stephens, a sub-committee to prepare a report of the committee on the subject of the metric system of weights and measures and the propriety of its adoption in the various departments of the government.

The time for the preparation of this report was short, and the members of this sub-committee being otherwise employed with public matters, the chairman, Mr. Maish, requested the undersigned to prepare this report during the recess of Congress. This was done.

The plan, as well as substance of the report, was left to me; and, knowing the demand of members of Congress as well as others for a convenient text-book on the metric system of weights and measures, I determined to prepare the report in the form of a compendious history of this new system of mathematical science, and to include within it a series of arithmetical rules and tables, as well as tables of comparative weights and measures of both the old and the new systems, as a convenient work of reference to government officials and employees in those departments wherein it might be desirable to adopt the metric system of weights and measures, in part or in whole, in the transaction of their business.

But the time allotted was not sufficient to enable me to prepare the report with that care which the nature and importance of the work demanded; hence the errors and omissions which were the consequence of this haste, rendering a reprint of the report desirable.

The demand for copies of the work has been unprecedented, exhausting the first edition within thirty days from its publication. To supply this demand this second edition is now placed before the committee, having been thoroughly revised and rearranged by Hon. Levi Maish, former chairman of the sub-committee, and myself. Still the work is far from being what we could desire or what is demanded by the public. We could not materially enlarge the work without an increase of its cost, nor lessen it without detracting from its usefulness. Economy, therefore, as well as usefulness, has been our purpose in preparing this second edition of the report.

C. P. CULVER,

Clerk to the Committee on Coinage, Weights, and Measures.

ERRATA.

Pages 11, 28, 31, 32, "gramme" should be spelt *gram*.

Page 11, foot-note, instead of "p. 46" see p. 51.

Pages 12, 19, 24, 31, "kilogramme" should be spelt *kilogram*.

Page 30, line 7 from top, before "number" insert signifying, in place of "snigifying".

Page 32, line 5 from top, for 10 and 12 read 14 and 15; line 23, for p. 8 read p. 12.

Page 35, line 14 from bottom, for 28 read p. 32.

Page 154. This table is a reprint, by oversight of author.

Pages 177, 185, 186, in foot-note, for "95" read p. 191.

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METRIC SYSTEM.

JUNE 11, 1879.—Read twice, recommitted to the Committee on Coinage, Weights, and Measures, and ordered to be printed.

Mr. STEPHENS, from the Committee on Coinage, Weights, and Measures, submitted the following

REPORT:

The Committee on Coinage, Weights, and Measures authorized the undersigned to submit the following report to the House and ask that it be printed, recommitted, and that 10,000 extra copies be printed.

The report consists of two parts. The first treats of and relates to the adoption of the metric system of weights and measures in the United States, with documents and statistics relating to that subject, which is substantially the report made by Mr. Maish, of the same committee, at the third session Forty-Fifth Congress, designated as H. Rep. No. 53.

Several important typographical errors in that are corrected in this, and the subject-matters somewhat differently arranged, and some additions have also been made by Mr. Maish. The House at the last session passed a resolution authorizing the printing of a number of extra copies of that report; but the resolution was not acted on in the Senate.

The second part of the report now presented relates to the adaptation of the metric system to our coinage.

With this brief explanation the entire report is herewith submitted.
ALEXANDER H. STEPHENS,
Chairman Committee on Coinage, Weights, and Measures.

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P A R T 1.

REPORT

OF THE

COMMITTEE ON COINAGE, WEIGHTS, AND MEASURES

BY

MR. MAISH, 3D SESSION 45TH CONGRESS.

PART 1.

CHAPTER I.

Mr. Maish, from the Committee on Coinage, Weights, and Measures, made the following report at third session Forty-fifth Congress (to accompany bill H. R. 2877):

The Committee on Coinage, Weights, and Measures, to whom were referred the several House bills and joint resolutions on the subject of the metric system of weights and measures, beg leave to submit—

1st. That, in view of the very general conviction of the need of a change arising out of the inconveniences of the old system in our international business transactions and the adequacy of the new or metric system, and in order to a clear understanding of the latter, we have thought it proper, as well as instructive, to present a condensed history of the metric system, including tables of comparison of both the old and the new systems of weights and measures.

There is no subject in which the general business interests of all countries, as well as progress in science in all its departments, are more deeply involved than in this. Hence, it is a subject which has occupied the attention of the most abstruse thinkers and the ablest lawgivers in all ages, and in all lands and climes.

The establishment of a system of weights and measures belongs not merely to the domain of mechanical science, but enters as well into the higher science of metaphysics and the generalization of history. Hence scientists have, after the lapse of centuries of toil and perseverance, been able to attain a near approximation to a correct and exact standard of weights and measures.

How we possess and employ the abstract idea of *size* and *weight*, whence it is that this primitive conception has come to be applied with comparatively such identity in the successive generations that have peopled our globe, and in what manner both the idea and its application have been harmonized with our physical perceptions, are, for the most part, topics of deep interest to those who busy themselves with investigations upon the intellectual and moral constitution of our race. While of daily reference and use in individual and commercial transactions, the *weights* and *measures* of nations serve the philosophical historian, when he has examined and compared the derivations and combinations in the respective systems, the character of their units, the adaptation of them to common use and the means employed for their exemplification and perpetuation, as so many indications of the state of human society in the respective places, states, and nations, as well as periods, noting the march and progress, as well as triumphs, of civilization.

The first essential thing for the civilized world to establish at this time, then, is a fixed and determined *unit of international linear measurement*.

"No cause since the earliest organization of civilized society," says Professor Barnard, "has contributed more largely to embarrass busi-

ness transactions among men, especially by interfering with the facility of commercial exchanges between different countries, or between different provinces, cities, or even individual citizens of the same country, than the endless diversity of instrumentalities employed for the purpose of determining the quantities of exchangeable commodities."

In the days of the patriarchs, Moses adopted the average length of the forearm of man, which he styled a *cubit*. This was his *unit* of linear measurement upon which his system was based; but this was far from being exact, fixed, and certain.

Pheidon, of Argos, in Greece, nearly a thousand years before the Christian era, gave the subject his profound attention, but arrived at no useful result. During the entire period of the Roman Empire, no improvement had been made upon the system established by Moses, though but few of the nations of the earth adopted his system. Their *units* of linear measurement were upon no more certain and fixed a principle than the *digit* (the average length of the finger), the palm, the foot, or the stride.

In modern England, whence our system (avoirdupois) was derived, the average of grains of wheat was at first adopted as the basis of a proper standard of length. This was in the reign of Henry III, in 1266. Afterward, in 1324, during the reign of Edward II, the grains of barley were substituted for those of wheat; hence it was declared that "three barleycorns, round and dry, shall make an inch, and twelve inches a foot."

This is the basis of our present absurd tables upon the subject. But the indefiniteness of this standard is apparent to all; for how much of the grain is to be taken off to make it "round" (or plump as perhaps the meaning is), and at what exact stage is it to be pronounced "dry"?

To avoid this inconvenience and confusion arising from this cause, there can be but one effectual remedy suggested, and that is, the general adoption throughout the world of one common system of weights and measures.

Until nearly the close of the eighteenth century, nevertheless [says Professor Barnard in his work on the metric system], no movement appears to have been anywhere made looking to the immediate or prospective application of this remedy.

It was one of the projects entertained by the Constituent Assembly of France, at a time when the revolution had not yet passed from the sanguine into that saigninary phase which but too soon succeeded, to engage the nations of Europe in a united effort to create, for the common use of all, a new metrological system, founded upon standards determined with scientific accuracy, and constructed in its details according to a scientific method. Nor, amid all the succeeding excitements attendant on the downfall of the monarchy, and the inauguration of the republic and the "Terror," was this important object ever lost sight of by the men who held, successively in their hands the destiny of France. And though the convulsions which for many successive years during that stormy period agitated the continent of Europe preventing the participation of all the nations in the prosecution of this great and beneficent work, still the work itself was prosecuted, though with some interruptions, to a satisfactory completion, and the result is seen to-day in the metric system of weights and measures, a system which, after the lapse of only three-quarters of a century, has been adopted for use by more than half [and, we will add, more than three-fifths] the inhabitants of the civilized and Christian world.

As the results of their labor—the establishment of a *unit* of linear measure—they agreed to take the one ten-millionth part of a quadrant of the earth's circumference on a meridian line, which was accurately measured, as was supposed, by Messrs. Delambre and Michain, eminent scholars and mathematicians, who were seven years in completing this immense labor.

This *unit*, so established, was styled "*the meter*." It corresponds with 39.37 inches in our present English system.

It was further agreed to make the *unit of volume* equal to the capacity

of a cubical vessel measuring one-tenth of a meter on its edges; and the standard of weight the actual weight of distilled water which should fill such a vessel at the temperature of maximum density. The weight of a given volume of water under these conditions was, therefore, made a subject of elaborate investigation by a committee of the Academy of Science, and, in conformity with the results obtained, the standard unit of weight, called the *gramme*, was fixed at one-thousandth part of the standard weight above mentioned, which, being one thousand grammes in weight, is called the *kilogramme*.

But subsequent observation and surveys have created some doubt whether the prototype of the International Archives is really, with the most minute exactness, as it purports to be, one ten-millionth part of a terrestrial meridian. This question, after all, depends upon what is the true figure of the earth. There is no doubt at all of the accuracy of the measurement made by the French geodesists; but they measured only about ten degrees of the Paris meridian, and from this measurement deduced the length of the entire quadrant of ninety degrees, by calculation on the supposition that the earth is a regular spheroid, having an ellipticity of $\frac{1}{300}$ th. The investigations of General T. F. de Schubert, of the Russian army, and Capt. A. R. Clarke, of the British Ordnance Survey, have made it probable that the earth is an ellipsoid of three unequal axes, rather than a spheroid, and that the meridian passing through Paris is a trifle longer than the French computers supposed. If this is so—a thing, however, which must be yet regarded as doubtful—the prototype meter of the archives is by a very minute fraction (hardly more than one two-hundredth of an inch) less than one ten-millionth of the Paris meridian quadrant. On the other hand, it is, on the same supposition, with almost mathematical exactness, the one ten-millionth part of the meridian quadrant passing through New York City.

These dissensions, and the desirability of settling all doubts as to the stability of the system and the permanency of its unit basis, as well as of providing authenticated copies of the prototype standards to be distributed to the governments of all metric nations, and of securing such standards against the danger of alteration in all coming time, led to the assembling at Paris, in the year 1870, of an international commission to consider and adjust all questions connected with this subject.* In this commission thirty independent powers were represented. Among those was that of the United States, and Prof. Joseph Henry (since deceased), of the Smithsonian Institution, and our present able commissioner, Prof. J. E. Hilgard, assistant United States Coast Survey, &c., were designated by the President as delegates from the United States to this convention or international commission.

The deliberations of the commission, interrupted by the war of that year between France and Germany, were subsequently resumed (24th of September, 1872), and resulted at length in an international convention, providing for the maintenance at Paris of an international bureau of weights and measures, to be supported by pro-rata contributions from all the signatory powers, and charged with the care of the prototype standards and with the duty of constructing and verifying copies of those standards, not only for the powers interested, but for other governments, or even for corporations and individuals who should apply for them and should be willing to pay the expense attending their construction and comparison. This convention was signed in May, 1875, the

*See Prof. J. E. Hilgard's report on the proposed International Bureau of Weights and Measures at Paris, p. 46, No. 3.

diplomatic representative of the United States, Mr. Washburne, by consent and direction of the President, one of the signers.

It was resolved by this commission that the prototype meter and prototype kilogramme of the archives should be recognized and perpetuated forever as the true basis of the system, without regard to any doubtful questions which have been raised as to the exactness of their correspondence with their theoretic values.*

Tables of the metric or decimal system of weights and measures.

MONEY (DECIMAL).	
10 mills make	a cent.
10 cents make	a dime.
10 dimes make	a dollar.
10 dollars make	an eagle.

LENGTH (METRIC).	
10 millimeters make	a centimeter.
10 centimeters make	a decimeter.
10 decimeters make	a meter.
10 meters make	a dekameter.
10 dekameters make	a hectometer.
10 hectometers make	a kilometer.
10 kilometers make	a myriometer.

WEIGHTS (METRIC).	
10 milligrams make	a centigram.
10 centigrams make	a decigram.
10 decigrams make	a gram.
10 grams make	a dekagram.
10 dekagrams make	a hectogram.
10 hectograms make	a kilogram.
10 kilograms make	a myriagram.

CAPACITY (METRIC).	
10 milliliters make	a centiliter.
10 centiliters make	a deciliter.
10 deciliters make	a liter.
10 liters make	a dekaliter.
10 dekaliters make	a hectoliter.

The square and cube measures are nothing more than the squares and cubes of the measures of length, to which we will refer more at length hereafter.

A person has only to familiarize himself with the foregoing tables to complete his rudimental knowledge of the whole system. A boy or girl of ten years of age may master the metric system in a day; while years are required, in most cases, to gain a knowledge of the inconsistencies and incongruities of the existing system of weights and measures. These are all done away with by the decimal progression; so that, in fact, the first four rules of arithmetic are all the student requires. Some writer has said "that the adoption of the metric system in solving mathematical problems in our public and private schools would save one full year's hard study in a boy's or girl's collegiate course." If this be true—and there is no reason to doubt—it is an unanswerable argument in favor of the adoption of this system in our public schools, and that at once.

But apart from the foregoing reasons, there are still others that are wider and of an international character, which address themselves directly to the judgment and understanding of our American statesmen at this time. It is, at once to secure a system of weights and measures that shall be equally suitable to the use of all mankind having commercial intercourse.

* See Prof. F. A. P. Barnard's article on the Metric System, Johnson's Universal Cyclopaedia, vol. iii, pp. 452, 453.

Your committee are of opinion that such a common system is offered in the metric, according to which the weight and dimensions of every material thing, "whether solid, liquid, or gaseous; whether on land or on water; whether in the earth or in the air; and whether determined by the scale, plummet, balance, barometer, or thermometer, are ascertained by a method absolutely uniform, entirely simple, and equally suitable to the use of all mankind," resting upon a single invariable standard of linear measure, with multiples and submultiples like those of our American monetary system, exclusively decimal, with appropriate names, similar in all languages, and itself secure against the possibility of change or loss through carelessness or accident or design, by being constructed on scientific principles and copied for distribution among the different nations of the world.

We are well satisfied, moreover, that this new or metric system of weights and measures is rapidly gaining ground both in this country and Europe, as one after another of the most enlightened nations awake to the full appreciation of its immense advantages.

History of the adoption of the metric system in the United States.

On the 28th day of July, 1866, Congress enacted as follows*:

It shall be lawful throughout the United States of America to employ the weights and measures of the metric system; and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights or measures of the metric system.

The tables in the schedule hereto annexed shall be recognized in the construction of contracts, and in all legal proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and the tables may lawfully be used for computing, determining, and expressing in customary weights and measures the weights and measures of the metric system.

MEASURES OF LENGTH.

Metric denominations and values.	Equivalents in denominations in use.
Myriometer.....	10,000 meters.
Kilometer.....	1,000 meters.
Hectometer.....	100 meters.
Dekameter.....	10 meters.
Meter.....	1 meter.
Decimeter.....	$\frac{1}{10}$ of a meter.
Centimeter.....	$\frac{1}{100}$ of a meter.
Millimeter.....	$\frac{1}{1000}$ of a meter.

MEASURES OF CAPACITY.

Metric denominations and values.	Equivalents in denominations in use.			
Names.	Number of liters.	Cubic measure.	Dry measure.	Liquor or wine measure.
Kiloliter, or stere.....	1,000	1 cubic meter.....	1,308 cubic yards.....	264.17 gallons.
Hectoliter.....	100	$\frac{1}{10}$ of a cubic meter.....	2 bushels and 3.35 pecks.....	26,417 gallons.
Dekaliter.....	10	$\frac{1}{100}$ cubic decimeters.....	9.08 quarts.....	1,0567 quarts.
Liter.....	1	1 cubic decimeter.....	0.908 quart.....	0.845 gill.
Deciliter.....	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic decimeter.....	0.1022 cubic inches.....	0.338 fluid ounce.
Centiliter.....	$\frac{1}{100}$	$\frac{1}{100}$ cubic centimeters.....	0.6102 cu. in.	0.27 fluid dram.
Milliliter.....	$\frac{1}{1000}$	1 cubic centimeter.....	0.061 cubic inch.....	

* See sections 3569, 3570, Revised Statutes of the United States.

MEASURES OF SURFACE.

Metric denominations and values.		Equivalents in denominations in use.
Hectare.....	10,000 square meters.	2.471 acres.
Are.....	100 square meters.	119.6 square yards.
Centare.....	1 square meter.	1,550 square inches.

WEIGHTS.

Metric denominations and values.		Equivalents in denominations in use.	
Names.	Number of grams.	Weight of what quantity of water at maximum density.	Avoirdupois weight.
Millier, or tonneau.....	1,000,000	1 cubic meter.....	2204.6 pounds.
Quintal.....	100,000	1 hectoliter.....	220.46 pounds.
Myriagram.....	10,000	10 liters.....	22.046 pounds.
Kilogram or kilo.....	1,000	1 liter.....	2.2046 pounds.
Hectogram.....	100	1 deciliter.....	0.22046 pounds.
Dekagram.....	10	10 cubic centimeters.....	0.3527 ounce.
Gram.....	1	1 cubic centimeter.....	15.432 grains.
Decigram.....	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic centimeter.....	1.543 grains.
Centigram.....	$\frac{1}{100}$	10 cubic millimeters.....	0.1543 grain.
Milligram.....	$\frac{1}{1000}$	1 cubic millimeter.....	0.154 grain.

Approved July 28, 1866.

Along with the foregoing act, and to enable the several States to procure the metric standards of weights and measures, Congress enacted the following:

JOINT RESOLUTION to enable the Secretary of the Treasury to furnish to each State one set of the standard weights and measures of the metric system.

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of the Treasury be, and he is hereby, authorized and directed to furnish to each State, to be delivered to the governor thereof, one set of the standard weights and measures of the metric system for the use of the States respectively.

Approved July 27, 1866.

In pursuance of this resolution, the following description and explanations of the metric standards were prepared:

METRIC STANDARDS FOR THE STATES.

1. List of standards to be furnished to the States.

Length: One meter, end measure.

One meter, line measure, divided.

Weight: One kilogram.

One demi-kilogram.

One gram, with subdivisions.

One myriagram, or ten kilograms.

Capacity: One liter.

One dekaliter.

2. Particulars of meters.

The end measure is of cast steel, ten millimeters thick, thirty wide, with cylindrical ends, and small cylindrical projections in the axes, of hardened steel, with abutting faces three millimeters in diameter, equal to one meter, legal standard of France, at the temperature of melting ice.

The divided line measure is of brass, composed of three parts of copper to one of zinc, the bar extending beyond the terminal lines; divided into decimeters, one decimeter into centimeters, and one centimeter into millimeters, the length between the terminal lines being equal to one meter at a temperature of the bar of about 68° Fahrenheit, or 20° centigrade, and each bar bears an inscription stating the temperature at which its length is equal to one meter. Each of these line measures is provided with a convenient tracing frame for copying the division.

3. Particulars of weights.

The kilogram is of brass, of an ascertained specific gravity; it is equal when weighed in a vacuum to the weight of the French platinum standard kilogram in vacuum.

Demi-kilogram, gram, and fractions to milligram.

Myriagram, or ten kilograms.

The form of the weights is similar to the present American standard weights, so as to be handled with hooks, forks, and pincers, which are provided.

4. Particulars of capacity measures.

The standard liter is of brass, composed of fifteen parts of the brass used for the meters melted together with twelve parts of copper and one part of tin; of a form similar to the American quart, containing a volume of distilled water which, when weighed in vacuum, equals the weight of one French standard kilogram in vacuum, the water being at the temperature of its greatest density, and the vessel at the same temperature.

The dekaliter contains ten liters, as thus defined.

III.

DESCRIPTION OF METRIC STANDARDS FOR THE STATES.

The three packing-boxes contain a set of standard metric weights and measures, carefully packed in walnut cases.

The packing-box marked "weight" contains a myriagram, kilogram, demi-kilogram, gram, and the decimal fractions of a gram to include a milligram.

The box marked "volume" contains a dekaliter and liter, with their ground-glass covers.

The box marked "length" contains two walnut cases. In one of these is packed a steel meter, with hardened steel ends protected by brass caps; this is an end measure. The other walnut case contains a brass meter, which is divided into decimeters, centimeters, and millimeters, and is a line measure.

In the same case and lying parallel with the brass meter is a bar of wood of the same dimensions as the meter, held firmly in its place by means of wooden wedges.

This is so placed as to show the manner in which a bar of brass of the same dimensions can be secured for the purpose of having transferred upon it the meter and its decimal parts.

A tracer is packed in the box with the meter, and is operated in the following manner:

After the brass bar, on which it is desired to have the meter and its parts transferred, is well secured in position by means of the wooden wedges, the tracer is placed upon the standard bar in such a position that the short line under the magnifying-glass shall accord with a line on the standard bar, and while held firmly in this position, the movable portion of the tracer holding the cutter is passed carefully over the brass bar, making a mark upon it at right angles with its length. The tracer is then moved so as to accord with another line on the standard bar and another cut made on the brass bar. This operation is continued until a complete copy of the standard is transferred to the brass bar.

By the side of the cutter is a long steel screw, which can be set as a guide to determine the depth of the cut made by the cutter.

A revolving head on the tracer, with two notches filed in it, is placed there for the purpose of determining the length of the line cut. A steel screw in the movable portion of the tracer is so placed as to strike against this head and stop the motion of the cutter in that direction, and it will be readily seen that three different lengths of lines may be made by moving the head so that the stop-screw will at different times strike on the face of the revolving head and in the notches.

Before the brass bar is put in place it will be necessary to have it well prepared with a smooth surface, having lines traced on it in the direction of its length, similar to those on the standard.

The standard bar should never be moved from its place in the case. The weights should never be touched with the naked hand. Lifters are placed in the cases.

J. E. HILGARD,

Inspector United States Standard Weights and Measures.
UNITED STATES COAST SURVEY OFFICE,
Washington, March 1, 1876.

Approved.

C. P. PATTERSON,
Superintendent United States Standard Weights and Measures.

Accompanying the foregoing bill and joint resolution was the following able report, submitted by the Committee on Coinage, Weights, and Measures of the House of Representatives:

In considering the general subject of a uniform system of coinage, weights, and measures, your committee have had before them—

First. That part of the message of the President and the accompanying documents relating to these subjects.

Second. The report of the National Academy of Sciences, embracing their resolutions approving the metric decimal system of weights and measures.

Third. The report of the United States commissioner to the statistical congress at Berlin.

Fourth. Various memorials of universities and colleges of the United States, urging a uniform system of weights and measures, also invariably commanding the metric decimal system.

Fifth. The petition of the mayor, judges, and citizens of Baltimore, praying for the adoption of the metric system of weights and measures.

Sixth. Several memorials of citizens in different parts of the United States in behalf of the same object.

Seventh. The bill (H. R. 252) referred to them, and proposing the compulsory and exclusive use, after a limited period, of the metric system.

In addition to the documents and papers referred to them, and in the absence of authority to send for persons and papers, which they did not regard as indispensable to a proper investigation of the subjects at this time, they have examined the whole history of the efforts made in this country since the adoption of the Constitution to substitute for our imperfect and incongruous system of weights and measures a system at once simple, complete, uniform, and decimal in its relations.

The result of that examination is embodied in this report. They have also carefully examined the testimony taken before the select parliamentary committee on this subject in England—testimony very complete, and almost exhaustive of both facts and reasoning—touching the various phases of the questions involved. To these investigations they have added inquiries into the public action of other countries with which we have established commercial relations, on both the European and American continents. They also received the assistance of those distinguished members of the National Academy of Sciences who constituted the special committee of that learned society having charge of these subjects, and particularly of Professor Newton, of that committee, whose efforts in aid of their purposes have been patient and persevering.

The troubled condition of the United States, and the consequent extraordinary labors thrown upon the Thirty-eighth Congress, prevented your committee from then undertaking that thorough examination which the importance of the questions demanded. They now, however, submit their report and the accompanying bills, as indicating the conclusions to which they have unanimously come at this period of their deliberations. They do not doubt that a subsequent Congress will be prepared to go farther, and will enable the republic to lead, rather than to follow, the action of other commercial and intelligent nations in the complete establishment of this most urgently demanded reform. It is an obligation we owe not only to our present convenience, but also to posterity, to whose benefit all sound reforms invariably tend.

COINAGE.

In respect to the gold and silver coins of the United States, no specific change can, with propriety, be recommended for immediate adoption.

The United States early established (July 6, 1785) the decimal system in its application to money, and as a consequence of it have now a simple, convenient, and admirable measure of values. It only remains to be considered how a common standard of international values, for the use of all civilized and commercial nations, may be most conveniently established.

In this connection, three questions arise:

First. Should a unit entirely new be established? or,

Second. Should the established unit of some one nation, now in use, be adopted by all other nations?

Third. If so, which possesses the greatest advantages?

The advantage of the decimal system is now universally conceded among commercial nations. No country is more ready to concede its superiority than England, which has hitherto failed to adopt it. It is understood that the Bank of England, and some of her great railroad corporations, have been compelled to adopt the decimal system in the keeping of accounts. The government has also created a new coin in order to obtain the tenth of a pound.

The objections to the creation of an entirely new unit of value are evidently irresistible, if any existing unit in national use meets the conditions of convenience as a

common standard, and of decimal computation; for the people of all nations will be subject to the inconvenience of the adoption of the wholly new system, while the adoption of a decimal system now in use in any one or more nations would relieve at least a portion of the people from the inconveniences attending the change, and would find the people of all nations at least partially acquainted with it at the beginning. This fact itself should justify some sacrifice of national *amour propre* for the general good.

In 1856 (August 15), Congress, by a joint resolution, directed the Secretary of the Treasury to appoint a commissioner to confer with the proper functionaries in Great Britain in relation to some plan of so mutually arranging, on a decimal basis, the coinage of the two countries, that the respective units should be thereafter easily and exactly commensurable. The Committee on Finance in the Senate, in reporting the resolution, remarked that no measure can be readily suggested whose realization would mark a more decided epoch in the history of commerce. Under this resolution a very competent gentleman was appointed the commissioner, and on the 6th of January, 1859, his report was communicated to Congress (Ex. Doc. H. R. No. 36). Although the British Government were not prepared themselves to take the initiative with reference to a project which could not be carried out by it without parliamentary sanction, they were prepared to consider and confer with respect to any proposal that the commissioner might be instructed to make in behalf of the Government of the United States.

This result was merely preliminary, but perhaps all that could have been attained under the limited instructions given to the commissioner. But this beginning was not followed up, and there seems to have been no further prosecution of the negotiations. In his annual report to Congress, in December, 1862, the very able Secretary of the Treasury (now Chief Justice of the United States*) invited the attention of Congress to the present favorable occasion for securing harmony between our own coinage and that of Great Britain. He said:

"In his last report, the Secretary took occasion to invite the attention of Congress to the importance of uniform weights, measures, and coins, and to the worth of the decimal system in the commerce of the world. He now ventures to suggest that the present demonetization of gold may well be availed of for the purpose of taking one considerable step toward these great ends. If the half-eagle of the Union be made of equal weight and fineness with the gold sovereign of Great Britain, no sensible injury could possibly arise from the change, while, on the resumption of specie payments, its great advantage would be felt in the equalization of exchange and the convenience of commerce. This act of the United States, moreover, might be followed by the adoption by Great Britain of the Federal decimal divisions of the coin, and thus a most important advance might be secured toward an international coinage with value definitely expressed."

At the international congress of Berlin, the transactions of which were reported by the United States commissioner and submitted to Congress, it was resolved as follows:

"First. That the congress recommends that the existing units of money be reduced to a small number; that each unit should be, as far as possible, decimalized subdivided; that the coins in use should all be expressed in weights of the metrical system, and should all be of the same degree of fineness, viz., nine-tenths fine and one-tenth alloy.

"Second. That the different governments be invited to send to a special congress delegates authorized to consider and report what should be the relative weights in the metrical system of gold and silver coins, and to arrange the details by which the monetary system of different countries may be fixed according to the terms of the preceding propositions."

The occasion of the world's exposition of industry at Paris, in 1867, will furnish the proper opportunity for a free conference between the authorized commissioners of different governments as to the best means of establishing a uniform system of coinage for the common use of the nations of the world. It is to be hoped that the Government of the United States will be represented by a commissioner whom it may be authorized to delegate with special reference to the accomplishment of this great object.

The only interest of any nation that could possibly be injuriously affected by the establishment of this uniformity is that of the money-changers, an interest which contributes little to the public welfare, while, by diversity of coinage and of values, it adds largely to its private accumulations.

The only indispensable condition of this uniformity of value is that in the standard unit, with its divisions and multiples used in commerce, there shall be in all countries an equal amount of gold (or silver), with fixed proportion of alloy. Each nation will retain its own devices and legends and other national peculiarities of mintage. A common name for the standard unit would be desirable but not essential. The presence of a given amount of precious metal, mixed with a given amount of alloy, is the only absolute prerequisite for the establishment of international uniformity in coin-

*Salmon P. Chase, died May 7, 1873.

age. The dollar of the United States, four shillings of England, and five francs of France are of approximate value. Several nations of Europe have adopted, under other names, the coinage of France, making it of equal value.

The general par value of shares in railroads and other corporations on the continent of Europe, as well as in England and the United States, is one hundred dollars or its approximate equivalent in the money of the different nations. This, of itself, would seem to be a concession of the value which should constitute the standard unit of money. The United States are now in a favorable condition to yield, with little inconvenience, to a variation in the essential value of their dollar, if it should become necessary, their coin being now withdrawn from general circulation. No opportunity so auspicious for effecting any needed change in quantity of gold or silver and alloy can be expected for many years to come. The present would therefore seem to be the most desirable period for this government to engage in the preliminary negotiations necessary for the establishment of a common unit of value among all commercial nations. But the committee can make no recommendation of any specific measure beyond the resolution herewith submitted. Their conviction is clear that international uniformity is of the utmost importance for the convenience of our external trade and of our general intercourse with foreign nations; and that at this time, especially, it is the duty of the government to prosecute with energy its efforts to effect an agreement with the leading nations of Europe on this subject. The consent of the United States, of England, and of France would necessarily ultimate in the consent of all commercial nations.

WEIGHTS AND MEASURES.

Upon the other branch of the subjects with the examination of which this committee is charged they are prepared to report more definitely.

The whole history of our revolutionary confederation and the constitutional government of the United States has been a continuous acknowledgment of the perplexities arising from the diversity of weights and measures throughout their jurisdiction, and of the great desirability of a uniform and decimal system. The Articles of Confederation embraced the following clause:

"The United States, in Congress assembled, shall have the sole and exclusive right and power of regulating the alloy and value of coin struck by their own authority or by that of the respective States, fixing the standards of weights and measures throughout the United States."

This power was transferred to Congress by the Constitution of the United States in the following language: "Congress shall have power * * * to coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures."

The first President, Washington, in his message to the first Congress assembled under the Constitution, brought the subject before Congress in the following language: "Uniformity in the currency, weights, and measures of the United States is an object of great importance, and will, I am persuaded, be duly attended to."

He again called the attention of Congress to it in his message of December, 1790; and again, in his opening address at the first session of the Second Congress, he said: "A uniformity in the weights and measures of the country is among the important objects submitted to you by the Constitution, and if it can be derived from a standard at once invariable and universal, must be no less honorable to the public councils than conducive to the public convenience."

In accordance with the President's first recommendation, the House of Representatives, on the 15th of January, 1790,

Ordered, That it be referred to the Secretary of State to prepare and report to this House, in like manner, a proper plan or plans for establishing uniformity in the currency, weights, and measures of the United States."

On the 15th of July of that year the House of Representatives received from the Secretary of State (Mr. Jefferson) his report for the proper plan for establishing the desired uniformity, as requested by the House.

In this elaborate report the Secretary proposed "that the standard of measure be a uniform cylindrical rod of iron of such length as, in latitude 45° in the level of the ocean, and in a cellar, or other place, the temperature of which does not vary through the year, shall perform its vibration in uniform and equal arcs in one second of mean time."

Starting from this standard he proposes two distinct plans for the consideration of the House, that they might, at their will, adopt the one or the other exclusively, or the one for the present, and the other for the future time, when the public mind may be supposed to have become familiarized to it.

The first plan was to define and render uniform and stable the existing system; to make the foot to bear a definite ratio to the standard pendulum rod; to reduce the dry and liquid measures to corresponding capacities by establishing a single gallon of 270 cubic inches, and a bushel to be equal to eight gallons, or 2,160 inches—that is, to one

and one-fourth cubic feet; to make the ounce to be the weight of one-thousandth part of a cubic foot of water; to retain the more known terms of the two kinds of weights in use, reduced to one series; and to express the quantity of pure silver in the dollar in parts of the weights so defined.

The second plan was to reduce "every branch to the same decimal ratio already established in coins, and thus bring the calculation of the principal affairs of life within the arithmetic of every man who can multiply and divide plain numbers."

Except in the length of the fundamental unit and in the nomenclature, this second plan was essentially that of the metrical system of France. A fifth part of the standard rod which has been described was taken for the foot, and was proposed for the principal unit. Its length would be about one-quarter of an inch shorter than the foot in common use.

The foot was divided into 10 inches; the inch into 10 lines; the line into 10 points; 10 feet made a decad; 10 decades make a rood; 10 rods a furlong; 10 furlongs a mile.

The cubic foot was to be the bushel, and was to be multiplied and divided decimal for the several units of dry and liquid measure. The weight of a cubic foot of water divided decimal furnished weights. By a very slight change the silver dollar would weigh an ounce in this new series.

These two plans were sharply opposed to each other, and it was to be expected that the desire for a decimal division and symmetry of system on the one hand and the reluctance to make a violent change on the other should elicit no little discussion.

After the preparation of his report, and before its communication to the House, Mr. Jefferson received the news that propositions had been made in the National Assembly of France and in Parliament which looked to the creation and establishment of a uniform international system of weights and measures. The movement in the former body resulted in the formation of the present metrical system of France.

This report was communicated to the Senate in December of that year, and Senators Izard, Monroe, Langdon, and Schuyler were appointed a committee to take it into consideration. That committee reported on the 1st of March, 1791, that, "as a proposition has been made to the National Assembly of France for obtaining a standard of measure which shall be invariable and communicable to all nations and at all times; as a similar proposition has been submitted to the British Parliament in their last session; as the avowed object of these is to introduce an uniformity in the measures and weights of the commercial nations; as a coincidence of regulation by the government of the United States on so interesting a subject would be desirable, your committee are of opinion that it would not be eligible at present to introduce any alteration in the measures and weights which are now used in the United States." This report was adopted.

The Second Congress, which met for its first session at Philadelphia in October, 1791, had the subject again urged upon its attention by the third appeal of President Washington, in his opening address. A week later the Senate appointed a committee, consisting of very nearly the same members as the committee of the preceding Congress, to take into consideration the subject of weights and measures and report thereon.

The committee reported on the 4th of April, 1792, recommending the adoption of the second plan proposed by Mr. Jefferson, which was an entirely decimal and symmetrical system.

The consideration of the report was deferred until the next session of Congress, and finally referred to a special committee, and their report was not "finally disposed of."

During the second session of the Third Congress, the President received from the French envoy a communication describing the newly-adopted metric system of France, together with copies of the provisional meter and kilogramme. This communication was sent to Congress on the 8th of January, 1795.

During the first session of the Fourth Congress, this communication of the French envoy and the report of Mr. Jefferson were referred to a committee of the House, which reported on the 12th of April, 1796. The committee assumed that all measures of surface, capacity, and weight should be regulated by measure of length; that the standard units of length and weight should not differ in a sensible degree from the present foot and pound, and that the standards should be referable to some uniform principle in nature, if it can be made to appear that reference may be had to such a measure with sufficient certainty of uniformity in the result of different experiments, and without much time, trouble, and expense in making them.

They propose, therefore, that experiments be undertaken for determining the length of the proposed pendulum rod, and that from this should be derived the standard foot and standard pound. While they suggest four modes for dividing the weights, and indicate their decided preference for the decimal divisions, they avoid the vexed question of the mode of the division of the foot, and also the kindred one of the contents of the bushel and gallon.

A bill to provide for the experiments passed the House, but on the third reading in the Senate was postponed to the next session, and so lost.

During the next twenty years three or four committees were appointed to examine

the subject and report, but no action resulted therefrom. It was not until after the close of the war of 1812 that serious consideration of it was again resumed.

The difficulties of the questions remained. It was still uncertain whether the metrical system would eventually succeed, even in France. It does not appear, therefore, that the adoption of that system was urged as a settlement. We could not be expected to give up our old measures without a resulting improvement that should be permanent. On the other hand, to divide our units decimal would destroy uniformity with England, with the unpleasant prospect before us of a second change, if another decimal system should become elsewhere universal.

In his annual message, sent to the Fourteenth Congress at its second session (December 3, 1816), President Madison urges the subject upon their attention in the following language:

"Congress will call to mind that no adequate provision has yet been made for the uniformity of weights and measures, also contemplated by the Constitution. The great utility of a standard fixed in its nature, and founded on the easy rule of decimal proportions, is sufficiently obvious. It led the government at an early stage to preparatory steps for introducing it, and a completion of the work will be a just title to the public gratitude."

As a consequence of this decided expression of the President, the Senate, just before the close of the session (March 3, 1817) referred it to the Secretary of State to prepare and report to them "A statement relative to the regulations and standards for weights and measures in the several States, and relative to proceedings in foreign countries for establishing uniformity in weights and measures, together with such propositions relative thereto as may be proper to be adopted in the United States."

Similar action, more than two years later, was taken by the House of Representatives.

Without waiting for the reply of the Secretary of State, a committee of the House, on the 25th of January, 1819, presented a report on the subject. After speaking of the difficulty of introducing the new system, the committee recommends, in effect, the first plan proposed by Mr. Jefferson; also that standards conform to those in most common use among us should be accurately made and carefully preserved at the seat of government, and that correct models should be placed in the different districts of the country. Resolutions providing for the establishment of a commission to execute this plan, and defining the duties of such commission, were reported to the House by the committee.

The report of Hon. John Quincy Adams, Secretary of State, to whom the subject had been referred in December 4, 1819, was transmitted to the Senate on the 22d February, 1821. The extent of the ground covered by this learned report, and its elaborate character, satisfactorily explain why four years had been employed in its preparation. It considers successively the origin of measures and weights in the earlier necessities of savage life, their modifications with human progress, and by positive law, the Hebrew, the Greek, and the Roman metrology. He then adds:

"Among the nations of modern Europe there are two who, by their genius, their learning, their industry, and their ardent and successful cultivation of the arts and sciences, are scarcely less distinguished than the Hebrews, from whom they have received most of their religious, or the Greeks, from whom they have received many of their civil and political institutions. From these two nations the inhabitants of these United States are chiefly descended, and from one of them we have all our existing weights and measures. Both of them, for a series of ages, have been engaged in the pursuit of a uniform system of weights and measures. To this the wishes of their philanthropists, the hopes of their patriots, the researches of their philosophers, and the energy of their legislators have been aiming, with efforts so stupendous, and with perseverance so untiring, that, to any person who shall examine them, it may well be a subject of astonishment to find that they are both yet entangled in the pursuit at this hour, and that it may well be doubted whether all their latest and greatest exertions have not hitherto tended to increase diversity instead of producing uniformity."

This leads to an elaborate historical description of the English and French systems of weights and measures, together with a brief summary of the earlier discussions of the subject in this country.

The importance of uniformity between the United States and England is recognized and urged.

On the other hand, Mr. Adams was no less strongly impressed with the immense advantage of the metrical system of France. It was at that day still a question whether it would establish itself, exclusively, even in its native land; yet the hopes which it excited led the Secretary to say, with the admiration of a poet, and the fervor of a prophet, "This system approaches to the ideal perfection of uniformity applied to weights and measures, and whether destined to succeed, or doomed to fail, will shed unfading glory upon the age in which it was conceived, and upon the nation by which its execution was attempted, and has been in part achieved. In the progress of its establishment there, it has been often brought in conflict with the laws of physical and moral nature, with the impenetrability of matter, and with the habits, passions, prej-

udices, and necessities of man. It has undergone various important modifications. It must undoubtedly still submit to others before it can look for universal adoption. But if man upon earth be an improvable being; if that universal peace which was the object of a Savior's mission, which is the desire of the philosopher, the longing of the philanthropist, the trembling hope of the Christian, is a blessing to which the futurity of mortal man has a claim of more than mortal promise; if the spirit of evil is, before the final consummation of things, to be cast down from his dominion over men and bound in the chains of a thousand years, the foretaste here of man's eternal felicity, then this system of instruments, to accomplish all the changes of social and friendly commerce, will furnish the links of sympathy between the inhabitants of the most distant regions; the meter will surround the globe in use as well as in multiplied extension, and one language of weights and measures will be spoken from the equator to the poles."

After an analysis and contrast of the respective advantages and disadvantages of the English and French weights and measures, so far as the advantages or disadvantages could be derived from theory, and the very imperfect experience of the French up to that time, Mr. Adams adds:

"These views are presented as leading to the conclusion that, as final and universal uniformity of weights and measures is the common desideratum of all civilized nations; as France has formed, and has for her own use established, a system adapted to the highest efforts of human science, ingenuity, and skill to the common purposes of all; as this system is yet new, imperfect, susceptible of great improvements, and struggling for existence even in the country which gave it birth; as its universal establishment would be a universal blessing, and as, if ever effected, it can only be by consent, and not by force, in which the energies of opinion must precede those of legislation, it would be worthy the dignity of the Congress of the United States to consult the opinions of all the civilized nations with whom they have a friendly intercourse, to ascertain, with the utmost attainable accuracy, the existing state of their respective weights and measures, to take up and pursue with steady, persevering, but always temperate and discreet exertions, the idea conceived and thus far executed by France, and to co-operate with her to the final and universal establishment of her system. * * *

"In contemplating so great but so beneficial a change as the ultimate object of the proposal now submitted to the consideration of Congress, it is supposed to be most congenial to the end to attempt no present change whatever in our existing weights and measures; to let the standards remain precisely as they are, and to confine the proceedings of Congress at this time to authorizing the Executive to open these communications with the European nations where we have accredited ministers and agents, and to such declaratory enactments and regulations as may secure a more perfect uniformity in the weights and measures now in use throughout the Union."

After giving statements of the laws in force in the several States, the report concludes by submitting to Congress a plan consisting of two parts, the principles of which were:

1. To fix the standard with the partial uniformity of which it is susceptible, for the present excluding all innovation.
2. To consult with foreign nations for the future and ultimate establishment of universal and permanent uniformity.

"All trifling and partial attempts of change in our existing system, it is hoped, will be steadily disownced and rejected by Congress, not only as unworthy of the high and solemn importance of the subject, but as impracticable to the purpose of uniformity, and as inevitably tending to the reverse—to increased diversity, to inextricable confusion."

Congress has heretofore authorized the construction of standards of the common measures of length, weight, and capacity, and their distribution to the several States as well as to the custom-houses and certain departments of the public service, but has hitherto failed to take a decisive step in advance.

In the mean time, the separate action of foreign governments, as will hereafter be shown, has produced the results which the Secretary sought by his proposition for concurrent action. The desire he expressed for the concurrence of the British Government especially, is now realized in the initiatory steps taken by Parliament in the authorized adoption of the metric system.

For this and other prior reasons, the second part of Mr. Adams's plan has not been effectively prosecuted. Its objects have not, however, been forgotten, and have occupied, during the last ten years more especially, the serious attention of the people and the government. Resolutions of State legislatures, petitions from scientific and other organized societies, recommendations from executive officers, and direct action of Congress—these all indicate a dissatisfaction with the present defective system of our weights and measures, and an earnest desire for a decimal system common to all nations.

In his annual report of December 9, 1847, the Secretary of the Treasury (Hon. R. J. Walker) commends the subject to the attention of Congress. He says:

"Coins, as well as weights and measures, for the benefit of all nations, ought to be uniform throughout the world; and if our decimal system of coinage should be more simple and perfect than that of any other nation, it ought to be, and ultimately will be, adopted, and lead, as far as practicable, to the introduction of the decimal system of weights and measures, or at least its simplification, so that ultimately the coin and the weights and measures may be simple and uniform throughout the world."

A few months later the superintendent of weights and measures, Professor Bache, in his report, urges attention to the subject (Ex. Doc. 84, Thirtieth Congress, first session, July 30, 1848):

"No one who has discussed the subject of weights and measures in our country has considered the present arrangement as an enduring one. It has grown up with the growth of European society, and is deficient in simplicity and in system. The labor which is expended in mastering the complex denominations of weights and measures is labor lost. Every purpose for which weights and measures are employed can be answered by a simple and connected arrangement."

"In our own country the present arrangement of weights and measures has been considered by the men who have written upon it as temporary."

After speaking of the two parts of Mr. Adams's plan, and asking whether the time has now come for urging the measures involved in the second part, he says:

"The present time seems especially to invite an effort of this kind. In England the subject of weights and measures is under consideration by a commission; and on the continent the new relations of states, hitherto separated, appear to be favorable to this object. Such changes can be readily effected by suitable means in one generation by introducing the new measures through the elementary schools."

"I am of opinion that the present weights and measures, whether declared to be provisional or not, will prove to be really so in the progress of our Union, and that arrangements more worthy to be called a system will one day prevail."

In a subsequent report, he says:

"In Holland the new weights and measures were introduced through the schools. The children of the country becoming familiar with them in the primary schools, seeing the actual material standards of length, capacity, and weight at frequent and stated times in early youth, and retaining that familiarity as they passed into the higher schools, would be readily prepared for their universal use when reaching mature life. But the old material standards must disappear, and not, as in our coinage, be tolerated by usage alongside of the lawful standards, destroying what Mr. Adams has so well called the uniformity of fact."

"Coming into the charge of an unfinished work, I conformed, as far as I could, to the plans already in part executed by my predecessor, Mr. Hassler, as I could co-operate heartily in the endeavor to produce that uniformity of fact which was the basis of the system. I have not failed from time to time to press forward the second part of this established system, namely, the endeavor at universal uniformity."

"The first part of Mr. Adams's plan has (as far as legal standards are concerned, and in a great degree) been accomplished; but the second part—that which recommends the consultation with foreign nations for the ultimate establishment of universal uniformity, remains to be acted on."

"By reference to the interesting account of the metrical system in the letter of Mr. Silvermann, it will be seen that it has extended widely beyond the boundaries of France, and has been adopted by law in Spain, Belgium, Greece, Holland, Lombardy, Poland, and Switzerland, in Europe, and Chili, Colombia, and Mexico on this continent."

"Has not the time arrived, in the general progress of commercial and international intercourse, and the rapid advance of our own country in science, wealth, and power, when her voice should be heard in an important matter like this? Should not Congress make the proposition to all nations, to meet, by their representatives, and consult for the purpose of establishing permanent and universal uniformity of weights and measures? Such action could not fail to meet with a response due to the greatness of the subject, and if the great object be attained, to lead to results productive of vast and lasting benefit to the human race."

The legislature of New Hampshire, by joint resolution, approved June 28, 1859, requested their Senators and Representatives to urge upon Congress the adoption of the decimal system. The legislature of Maine, March 20, 1860, by joint resolution, expressed in still more decided language their desire for a uniform international decimal system of weights, measures, and coins.

The legislature of Connecticut, by resolution (1861), seconded this action of Maine.

In June, 1864, they further recommended to the proper school officers to provide for teaching the metrical system in all schools of the State.

The Secretary of the Treasury, Mr. Chase, in his annual report, December 9, 1861, again brought the subject to the attention of Congress:

"The Secretary desires to avail himself of this opportunity to invite the attention of Congress to the importance of a uniform system and a uniform nomenclature of weights, measures, and coins to the commerce of the world, in which the United States already so largely shares. The wisest of our statesmen have regarded the attainment of this end so desirable in itself as by no means impossible. The combination of the decimal system with appropriate denominations in a scheme of weights, measures, and coins for the international uses of commerce, leaving, if need be, the separate systems of nations untouched, is certainly not beyond the reach of the daring genius and patient endeavor which gave the steam-engine and the telegraph to the service of mankind. The Secretary respectfully suggests the expediency of a small appropriation to be used in promoting interchange of opinions between intelligent persons of our own and foreign countries on this subject."

In May, 1863, an international postal congress was held at Paris, at the suggestion of the Government of the United States, in which nearly all the European and some of the American governments were represented. Among the resolutions adopted at that congress were the following:

"SEC. 7. The rates upon international correspondence shall be established according to the same scale of weight in all countries."

"SEC. 8. The metrical decimal system, being that which best satisfies the demands of the postal service, should be adopted for international postal relations, to the exclusion of every other system."

"SEC. 9. The single rate upon international letters shall be applied to each standard weight of fifteen grams or fractional part of it."

At that congress, representing nations having many different systems of weights and measures, the expression in favor of the metric system was unanimous.

In the autumn of 1863, an international statistical congress was held at Berlin, and, at the instance of the Prussian Government, the Secretary of State appointed a commissioner to represent the United States therein. His report of the transactions of the congress was transmitted to the Senate on the 18th of June, 1864. All, or nearly all, of the nations of Europe were represented. The subject of a uniform international system of coinage, weights, and measures was presented upon the report of a numerous committee, which had been appointed at a previous meeting held at London three years before. Its report was transmitted to Congress and published. It contains detailed information as to the weights, measures, and the coins of the European and a portion of the American nations. The statistical congress, after discussion, resolved that the adoption of the same measures in international commerce is of the highest importance, and that the metric system is the most convenient of all that can be recommended for international measures.

In the same year (1863), by request of the Secretary of the Treasury, the National Academy of Sciences appointed a committee to consider and report upon the subjects embraced within the jurisdiction of the committee. After patient investigation and deliberate discussion, that committee made the following report, which was adopted by the Academy with almost entire unanimity:

"Report of the committee on weights, measures, and coinage, to the National Academy of Sciences, January, 1866.

"The committee are in favor of adopting, ultimately, a decimal system; and, in their opinion, the metrical system of weights and measures, though not without defects, is, all things considered, the best in use. The committee, therefore, suggest that the academy recommend to Congress to authorize and encourage by law the introduction and use of the metrical system of weights and measures; and that with a view to familiarize the people with the system, the academy recommend that provision be made by law for the immediate manufacture and distribution to the custom-houses and States, of metrical standards of weights and measures; to introduce the system into the post-offices by making a single letter weigh fifteen grammes instead of fourteen and seventeen-hundredths, or half an ounce; and to cause the new cent and two-cent pieces to be so coined that they shall weigh, respectively, five and ten grammes, and that their diameters shall be made to bear a determinate and simple ratio to the metrical unit of length."

In concluding this review of the agitation of and action upon these questions in the United States, it only remains to add that the House of Representatives of the Thirty-eighth Congress, at its first session, established, by an amendment of its rules, a standing committee to take jurisdiction of this great reform. As efforts to carry that reform into effect had hitherto been spasmodic, rather than consecutive, it was thought proper thereafter to crystallize them through the action of a permanent committee,

before whom they should perpetually reappear until this conceded great desideratum should become an accomplished fact.

But while the United States was the first to move in the direction of a decimal system resting upon a natural and universally attainable standard, the effect of the delay of this government, with a view to harmony in action with England, has been to render it possible that the United States will be among the last in the column of nations to take this great step in civilization.

Our predecessors of the era of Mr. Adams found the interests of this country much more dependent upon England than they are at this day. England herself was less subject at that time to the effect of foreign influence than at present. The failure of these two governments to unite upon a system resting upon a standard of their own, at a time when France stood alone for the metric system, has been fatal to the adoption of the arbitrary system of those countries by other nations. Convinced of its imperfections, no effort was made to introduce it into other countries, and any modification of it with a view to its improvement would only have created an additional system to those already in use in the world, without having in any of its features a superiority over the metric system. In the mean time, the simple order, beauty, and convenience of the metric system has commended it to universal acceptance, that it has already been adopted exclusively or permissively by nearly all the nations of Christendom.

In France, Spain, Belgium, and Portugal it has been established to the exclusion of other weights and measures. In Holland, other weights are allowed in compounding medicines only. Sardinia and Lombardy have long possessed the system, and it has now been extended to the whole of Italy. Greece has introduced it with some modifications. In Austria, and most of the other German States, the half kilogramme has been for some time a common unit of weight in the custom-houses and on railways. During the past year your committee are informed that delegates of all the German States, at a meeting at Frankfort-on-the-Main, signed a convention, agreeing to introduce into the several states systems of which the meter should be the basis. Prussia, which had previously withheld assent, thus appears to join in the common movement. Switzerland will necessarily follow Germany, and already has units that are aliquot parts of the meter and the kilogramme. The King of Sweden and Norway has appointed a commission to consider and report on the best mode of introducing the metric system among his subjects. Denmark may be expected to follow the recommendation of the Scandinavian convention that advised it. We have the assurance of M. Kupfer, the distinguished superintendent of weights and measures of the Russian Empire, that if England should adopt the metric system Russia will also adopt it.

The system has also made great progress among the States upon this continent.

Six years since it was adopted by the Mexican Republic, and its use decreed at once in the public offices, and, after a certain period, in private contracts. This period expired about the time of the imperial invasion, under which that republic is now suffering. It was introduced into Chili in 1848, and is compulsory from the 1st of June, 1865. In the United States of Colombia and in Venezuela it has been in use along with other weights and measures since 1853. In Brazil the meter is used for cloth-measure, and the liter for wine-measure. In Ecuador the system was decreed to come into full operation on the 15th of October next. In Guatemala, San Salvador, and the Argentine Republic it is in partial use among the people.

The action of England is, however, of greater importance to us, owing to our close relations with her and with her colonies, by a common language, by our large commerce, and what is, perhaps, more pertinent to this question, by common weights and common measures.

On the 8th of April, 1862, the House of Commons appointed a select committee of fifteen members to "consider the practicability of adopting a simple and uniform system of weights and measures, with a view not only to the benefit of internal trade, but to facilitate trade and intercourse with foreign countries." The committee examined thirty-nine witnesses, among whom were nine from foreign countries in which the metric system was in force. They were generally men of distinguished intelligence, who were attending the Industrial Exhibition as commissioners from their respective countries. The list of witnesses included seven merchants, six civil engineers and architects, ten professors and teachers, two manufacturers, four actuaries and accountants, the astronomer royal, the master of the mint, and the secretary of the post-office. That committee appear to have been unanimous in recommending the introduction of the metrical system into Great Britain.

On the 13th of May, 1863, a bill was prepared and brought in by members of that committee, by the terms of which the metric system of weights and measures was introduced into Great Britain, and its use by the people made compulsory after three years. This bill was passed by the House of Commons by a large majority, but does not appear to have been acted on by the House of Lords. At the next session (February, 1864), a bill was introduced by the same gentlemen, which changed its purport from a compulsory to a permissive measure.

This bill passed the House of Commons on the 29th of June, the House of Lords on the 21st of July, and became a law. The vote of the House of Commons approving a compulsory measure, and the subsequent enactment of a permissive law, must be regarded as evincing a deliberate intention to introduce the metric system into England, and as giving up any purpose of creating a separate system founded upon the yard, the foot, or the inch, and as paving the way for the ultimate exclusive adoption of the metric scheme.

The general consent of so many nations, highly enlightened, and deeply interested in the promotion of trade, and in popular progress, affords in itself an argument almost conclusive for, first, uniformity; second, decimalization; and, third, the metric plan. But habit makes us so submissive even to constant inconvenience, that your committee submit herewith three tables, showing the perplexities and embarrassments involved in our customary weights and measures, in every effort for their mutual conversion, and even in all efforts of the memory to retain the relations of their several parts.

They multiply most seriously the arithmetical rules required, embarrass mathematical calculations, clog the accounts of trade, increase the labor of teachers and scholars alike in our schools, absorb in their acquisition a great portion of the time which would be more usefully applied to other studies, and necessarily appreciate the cost of a common business education. With a decimal system all the ordinary transactions of popular trade could be computed by any person familiar with the simplest relations of numbers, and without pencil or paper to aid the mind, now embarrassed by their complexity. But with the actual system in use, in the table of lengths we ascend by the factors 12, 3, 54, 40, 8, and 3; or else by $7\frac{1}{2}$, 25, 4, and 80.

In weights we have three series, nearly distinct—avoirdupois, troy, and apothecaries. The only common unit is the grain. In the first, we ascend from the grain by the factors $27\frac{1}{4}$, 16, 16, 25 or 28, 4, and 20; in the second, the factors are 24, 20, and 12; in the third, 20, 3, 8, and 12.

In measures of capacity there are simple relations between the several liquid measures, as well as between the dry measures, and also the cubic measures; yet, in comparing the measures of the three different series, there are no useful relations whatever.

The accompanying tables exhibit to the eye this want of system. They give the number by which it is necessary to multiply or divide, in order to reduce one denomination to another. These factors, when fractional, are reduced to their lowest terms.

METRIC SYSTEM.

I.—Table of usual lengths, exhibiting the number of units of each denomination contained in each larger denomination.

	Inches.	Links.	Feet.	Yards.	Rods.	Rods.	Chains.	Leagues.
The inch contains .	12	1	$\frac{1}{12}$	$\frac{1}{36}$	$\frac{1}{108}$	$\frac{1}{324}$	$\frac{1}{972}$	
The link contains .	144	12	12	9	3	1		
The foot contains .	432	36	36	9	3	1		
The yard contains .	864	72	144	6	2	1		
The fathom contains .	2376	198	25	4	$\frac{1}{4}$	$\frac{1}{4}$		
The rod contains .	9504	792	100	60	22	11	4	
The chain contains .	95040	7928	1000	600	220	110	40	1
The furlong contains .	76800	6000	5280	1760	880	320	80	1
The mile contains .	228000	19000	24000	15840	5280	2640	960	1
The league contains .	2280000							

II.—Table of weights in use, exhibiting the number of units of each denomination contained in each larger denomination.

	Grains.	Scruples.	Pennyweights.	Avoirdupois.	Apothecaries' drachmes.	Avoirdupois.	Troy, ounces.	Short ton.	Long ton.
The scruple contains .	24	1	$\frac{1}{24}$	$\frac{1}{144}$	$\frac{1}{1296}$	$\frac{1}{12960}$	$\frac{1}{12960}$		
The pennyweight contains .	576	3	$\frac{1}{576}$	$\frac{1}{3456}$	$\frac{1}{34560}$	$\frac{1}{34560}$	$\frac{1}{34560}$		
The avoirdupois drachm contains .	60	3	$\frac{1}{60}$	$\frac{1}{360}$	$\frac{1}{360}$	$\frac{1}{360}$	$\frac{1}{360}$		
The apothecaries' drachm contains .	72	4	$\frac{1}{72}$	$\frac{1}{432}$	$\frac{1}{432}$	$\frac{1}{432}$	$\frac{1}{432}$		
The avoirdupois ounce contains .	480	24	20	120	10	8	12		
The troy ounce contains .	9720	288	240	1440	120	96	144		
The troy pound contains .	7000	350	256	1536	128	96	144		
The avoirdupois pound contains .	1400000	700000	512000	307360	256000	192000	288000	35840	
The short ton contains .	16580000	784000	573440	35840	32000	2240	32000	35840	
The long ton contains .									1

III.—Table of usual measures of capacity, exhibiting the number of units of each denomination contained in each larger denomination.

	Cubic inches.	Pints.	Gills.	Dry quarts.	Gallons.	Peccks.	Cubic feet.	Bushels.	Cubic yards.
The cubic inch contains .	194	1							
The fluid ounce contains .	8	32	1						
The gill contains .	32	96	4	1					
The pint contains .	128	256	16	4	1				
The quart contains .	256	512	32	8	2	1			
The dry quart contains .	3584	7168	1024	192	32	8	1		
* The gallon contains .	1024	231	128	32	8	4	1		
The peck contains .	1280	3200	1024	256	64	16	1		
The cubic foot contains .	128	128	128	128	128	128	128	1	
The bushel contains .	1024	1024	1024	1024	1024	1024	1024	1024	
The cubic yard contains .	1024	1024	1024	1024	1024	1024	1024	1024	

METRIC SYSTEM.

These tables indicate that none but professional persons can be expected to master and retain their knowledge of the arithmetical intricacies of our present scheme, as taught in schools and used in practical life. If to those denominations there mentioned we should add nails, ells, barleycorns, the two quarters, the two cwts., the ale-measures, and the various barrels, pipes, and hogsheads, the list of difficulties would be formidably increased.

In marked contrast with this is

THE METRIC SYSTEM.

It is orderly, simple, and perfectly harmonious, having useful relations between all its parts. It is based on the *meter*, which is its principal and only arbitrary unit. The meter is a measure of length, and was intended to be, and is very nearly, one ten-millionth of the distance on the earth's surface from the equator to the pole. It is 39.37 inches, very nearly.

The *ar* is a surface equal to a square whose side is ten meters. It is nearly four square rods.

The *liter* is the unit of measuring capacity, and is equal to the contents of a cube whose edge is a tenth part of the meter. It is a little more than a wine quart.

The *gramme* is the unit of weight, and is the weight of a cube of water, each edge of the cube being one one-hundredth of the meter. It is equal to 15.432 grains.

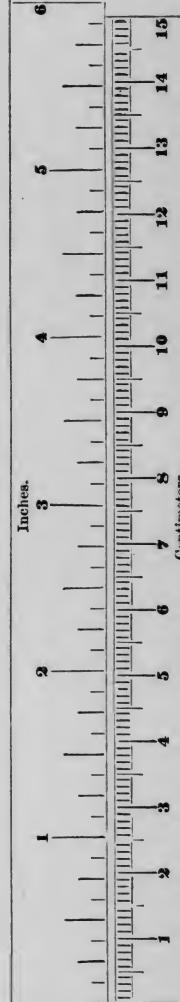
The *ster* is a cubic meter.

Each of these units is divided decimalily, and larger units are formed by multiples of 10, 100, &c. The successive multiples are designated by the prefixes deka, hecto, kilo and myria; the subordinate parts by deci, centi, and milli; each having its own numerical significance.

Scheme of the weights and measures of the metric system.

Lengths.	Surfaces.	Volumes.	Weights.
Meter.....			Miller, or tonneau.
Kilometer.....			Mylagramme.
Hectometer.....			Kilogramme, or kilo.
Dekameter.....			Hectogramme.
Meter.....			Deka.
Decimeter.....			Gram.
Centimeter.....			Decigramme.
Millimeter.....			Centigramme.
			Milligramme.

Scale representing a portion of the meter divided into centimeters and millimeters, together with a six-inch scale divided into eighths of an inch; one inch contains 25.4 millimeters.



The nomenclature, simple as it is in theory, and designed from its origin to be universal, can only become familiar by use. Like all strange words, these will become familiar by custom, and obtain popular abbreviations. A system which has incorporated with itself so many different series of weights, and such a nomenclature as "scruples," "pennyweights," "avoirdupois," and with no invariable component word, can hardly protest against a nomenclature whose leading characteristic is a short component word, with a prefix signifying number. We are already familiar with *thermometer*, *barometer*, *diameter*, *gasometer*, &c., with *telegram*, *monogram*, &c., words formed in the same manner.

After considering every argument for a change of nomenclature, your committee have come to the conclusion that any attempt to conform it to that in present use would lead to confusion of weights and measures; would violate the easily-learned order and simplicity of metric denomination, and would seriously interfere with that universality of system so essential to international and commercial convenience.

When it is remembered that of the value of our exports and imports in the year ending June 30, 1860, in all \$762,000,000, the amount of near \$700,000,000 was with nations and their dependencies that have now authorized, or taken the preliminary steps to authorize, the metric system, even denominational uniformity for the use of accounts in such vast transactions assumes an important significance. In words of such universal employment each word should represent the identical thing intended, and no other, and the law of association familiarizes it.

Table of the commerce of the United States for the year ending June 30, 1860, exhibiting the values of the exports to and imports from each foreign country (including its colonies) in which the metric system is entirely or partially adopted or is in process of adoption; and all the exports to and imports from all other nations.

METRIC NATIONS.

Countries.	Exports.	Imports.
Sweden, Norway, and Swedish West Indies.	\$1,516,345	\$532,984
Hamburg, Bremen, and other German ports.	18,427,958	18,498,607
Holland and Dutch colonies.	4,367,738	4,501,306
Belgium.	4,559,748	2,538,873
Great Britain and colonies.	238,887,117	177,913,585
France and colonies.	63,050,187	43,409,627
Spain and colonies.	21,163,794	44,492,314
Portugal and colonies.	402,303	266,440
Italy.	5,073,375	4,734,518
Austria.	1,038,904	732,645
Greece.		71,754
Mexico.	5,354,673	6,935,872
Central America.	149,693	331,238
New Granada.	1,793,499	3,843,568
Venezuela.	1,147,900	2,883,464
Brazil.	6,280,255	21,214,803
Argentina Republic.	998,708	4,020,848
Chili.	3,268,673	2,072,912
Ecuador.	18,545	.....
Total.	378,004,820	339,015,378

NON-METRIC NATIONS.

Nations.	Exports.	Imports.
Russia and possessions.	\$2,833,325	\$1,557,868
Prussia.		36,464
Ionian Republic.		62,897
Denmark and Danish West Indies.	1,328,548	216,925
Turkey.	849,768	916,250
Egypt.	36,420	71,709
African ports.	2,370,543	1,755,916
Haiti.	2,673,682	2,062,723
San Domingo.	169,300	283,098
Uruguay.	738,358	908,750
Peru.	987,672	308,452
Sandwich Islands.	747,462	367,859
Other Pacific islands.	65,274	112,401
Japan.	138,774	55,091
China.	8,906,118	13,566,587
Other ports in Asia.	108,969	49,634
Total.	22,005,213	22,386,624
Whale fisheries and unknown.	112,263	764,252

Your committee unanimously recommend the passage of the bills and joint resolutions appended to this report. They were not prepared to go, at this time, beyond this stage of progress in the proposed reform. The metric system is already used in some arts and trades in this country, and is especially adapted to the wants of others. Some of its measures are already manufactured at Bangor, in Maine, to meet an existing demand at home and abroad. The manufacturers of the well-known Fairbanks scales state: "For many years we have had a large export demand for our scales with French weights, and the demand and sale is constantly increasing." Its minute and exact divisions specially adapt it to the use of chemists, apothecaries, the finer operations of the artisan, and to all scientific objects. It has always been and is now used in the United States Coast Survey. Yet in some of the States, owing to the phraseology of their laws, it would be a direct violation of them to use it in the business transactions of the community. It is therefore very important to legalize its use, and give to the people, or that portion of them desiring it, the opportunity for its legal employment, while the knowledge of its characteristics will be thus diffused among men. Chambers of commerce, boards of trade, manufacturing associations, and other voluntary societies and individuals, will be induced to consider and in their discretion to adopt its use. The interest of trade among a people so quick as ours to receive and adopt a useful novelty will soon acquaint practical men with its convenience. When this is attained—a period, it is hoped, not distant—a further act of Congress can fix the date for its exclusive adoption as a legal system. At an earlier period it may be safely introduced into all public offices and for government service.

In the schedule of equivalents provided in the bill, extreme scientific accuracy is not expressed. The reasons follow. The exact length of the meter in inches and the weight of the kilogramme in grains can of necessity be determined only approximately. The most careful determinations of these quantities now possible are liable to minute corrections hereafter, as more numerous observations are made and better instruments are used. Instead, therefore, of aiming at an accuracy greater, perhaps, than is attainable, it is more expedient to consult the convenience of the people by using the simplest numbers possible in the schedule, and yet such as shall be in fact more nearly exact than can ever be demanded in the ordinary business of life. These numbers are to be used in schools and in practical life millions of times as multipliers and divisors, and every unnecessary additional figure is justly objectionable.

In a popular sense of the word, however, the numbers in the schedule may be said to be exact. The length of the meter, for example, is given as 39.37 inches. The mean of the best English and the best American determinations differ from this only by about the amount by which the standard bar changes its length by a change of one degree of temperature. Such accuracy is certainly sufficient for legal purposes and for popular use.

The second measure recommended is a joint resolution, necessarily following the adoption of the leading bill, and provides for furnishing the standards which will thereby be required to the several States.

The third proposition is a bill to authorize and provide for the use of the weight of 15 grammes in the post-office, in conformity with the system adopted by that department for foreign correspondence.

The fourth is a resolution looking to effective negotiation for a uniform coinage among nations.

Respectfully submitted.

JOHN A. KASSON, *Chairman.*
CHARLES H. WINFIELD.
THOMAS WILLIAMS.
HEZEKIAH S. BUNDY.
HENRY L. DAWES.

RELATIVE VALUES OF ENGLISH AND METRIC UNITS, AND ILLUSTRATIONS OF THEIR USE.

For the benefit and instruction of the inexperienced in the theory and practice of this new system of weights and measures, we will here present a recapitulation of the whole theory of the system.

As we have already remarked in general terms, metric weights and measures are founded upon the *decimal notation*, and are so called because their *primary unit* or *base* is the *meter*.

The *meter*, therefore, is the *unit of length*, and is equal to one ten-mill-

ionth part of the distance on the earth's surface from the equator to the pole, or, as stated, 39.37 inches nearly.

1. The term *meter* is from the Greek *mētron*, a *measure*, and is fully explained in Prof. J. E. Hilgard's report on the metric standards for the States, pp. 10-12.

2. From the *meter* are derived the unit of *square* measure, called the *är* (är); the unit of *cubic* measure, called the *ster* (stér); the unit of capacity, called the *liter* (leeter), and the unit of *weight*, called the *gramme*.

3. The names of the *higher* denominations, or *multiples*, of the unit are formed by prefixing to the several *units* the *Greek* numerals, thus: *dek'a*, *hic'to*, *kil'o*, and *myr'ia*, which denote 10, 100, 1,000, 10,000; as *dekameter*, 10 meters, *hectometer*, 100 meters, &c.

4. The name of the *lower* denominations, or *divisions*, of the unit are formed by prefixing to the units the *Latin* numerals, *dec'i*, *cent'i*, and *mil'li*, which denote $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, as *decimeter*, $\frac{1}{10}$ meter; *centimeter*, $\frac{1}{100}$ meter; *millimeter*, $\frac{1}{1000}$ meter.

These *numeral prefixes* are the *key* to the whole system, and therefore should be *thoroughly mastered* at the outset.

LINEAR MEASURE.

5. The *unit of length* is the *meter*, which is equal to 39.37 inches nearly. The divisions are the *dec'imeter*, *cen'timeter*, and *mil'limeter*; the multiples are the *dek'ameter*, *hectometer*, and *myr'iameter*. (See p. 8.)

The *meter*, like the English *yard*, is used in measuring cloths, laces, moderate distances, &c.

For long distances the *kilometer* is commonly used; but for short or minute distances the *centimeter* and *millimeter* are used.

SQUARE MEASURE.

6. The *unit for measuring ordinary surfaces* is the *square meter*. It is used in measuring flooring, ceilings, &c.; *square decimeters* and *centimeters* are used for minute surfaces.

Table.

100 square cen'timeters make one square dec'imeter = 15.5 square inches.
100 square dec'imeters make one square meter (sq. m.) = 1,550 square inches.

7. The *UNIT OF LAND MEASURE* is the *are*, and is equal to a *square dekameter*, or 119.6 square yards. The only *subdivision* of the *are* is the *cen'tare*; and the only *multiple* is the *hectare*. Thus:

100 centares (square meters) make one *are* (är) = 119.6 sq. yards.
100 *ars* make one *hectare* = 2.471 acres.

The term *ar* is from the Latin *area*, a surface. In *square measure* it takes 100 units of a *lower* denomination to make one in the *next higher*; it follows, therefore, that each denomination must have *two places* of figures. In this respect *centars* correspond to cents.

CUBIC MEASURE.

8. The *UNIT for measuring ordinary solids* is the *cubic meter*.

Table.

1,000 cubic mil'limeters make one cubic cen'timeter = 0.061 cubic inches.
1,000 cubic cen'timeters make one cubic dec'imeter = 61.027 cubic inches.
1,000 cubic dec'imeters make one cubic meter (cu. m.) = { 35.317 cubic feet.
1,000 cubic dec'imeters make one cubic meter (cu. m.) = { 1.308 cubic yards.

The *cubic meter* is used in measuring embankments, excavations, &c.; *cubic centimeters* and *millimeters* for minute bodies.

Since it takes 1,000 units of a lower denomination in cubic measure to make one of the next higher, it is plain that, like mills, each denomination requires *three places* of figures.

9. The *UNIT OF WOOD MEASURE* is called the *ster*, and is equal to *cubic meter*, or 35.317 cubic feet. The only subdivision of the *ster* is the *dec'ister*; and the only *multiple*, the *dek'aster*.

10 dec'isters make one *STER* (st.)
10 *steres* make one *dek'aster*.

The term *stere* is from the Greek *stereos*, solid.

DRY AND LIQUID MEASURE.

10. The *unit of dry and liquid measure* is the *LITER*, which is equal to a *cubic decimeter*, or 1.0567 wine quarts. The divisions are the *dec'iliter*, *cen'tiliter*, and *mil'liliter*; the multiples, the *dek'aliter*, *hectoliter*, and *kil'oliter*.

	Dry measure.	Liquid measure.
10 mil'li-li-ters	make one cen'ti-li-ter (cl.)	= 0.6103 cubic inch, or 0.338 fluid ounce.
10 cen'ti-li-ters	make one dec'i-li-ter	= 6.1027 cubic inches, or 0.845 gill.
10 dec'i-li-ters	make one LITER (L.)	= 0.908 quart, or 1.0567 pints.
10 li'-ters	make one dek'a-li-ter	= 9.08 quarts, or 2.6418 gallons.*
10 dek'a-li-ters	make one hec'to-li-ter (hl.)	= 28.379 bushels, or 264.19 gallons.*
10 hec'to-li-ters	make one kil'o-li-ter	= 28.379 bushels, or 264.19 gallons.*

The term *liter* is from the Greek *litra*, a *weight*. It is commonly used in measuring wine, milk, &c., in moderate quantities. For minute quantities, the *centiliter* and *milliliter* are employed; and for large quantities, the *dekaliter*.

For measuring grain, &c., the *hectoliter* = 2.8375 bushels is commonly used.

Instead of the *kiloliter* and *milliliter* it is customary to use *cubic meters* and *cubic centimeters*, which are their equals.

WEIGHT.

11. The *unit of weight* is the *gram* = 15.432 grains. The divisions are the *dec'igram*, *cen'tigram*, and *mil'ligram*; the multiples the *dek'agram*, *hectogram*, *kil'ogram*, *myr'igram*, *quin'tal*, and *mil'lier* or *ton'neau*.

The following table is used in computing the weight of all objects from the least atom to the largest known body:

10 mil'ligrams	make one cen'tigram	= 0.1543 grain.
10 cen'tigrams	make one dec'igram	= 1.5432 grains.
10 dec'igrams	make one GRAM	= 15.432 grains.
10 grams	make one dek'agram	= 0.3527 ounce avoirdupois.
10 dek'agrams	make one hec'togram	= 3.5274 ounces avoirdupois.
10 hec'tograms	make one kil'ogram	= 2.2046 pounds avoirdupois.
10 kil'ograms	make one myr'igram	= 22.046 pounds avoirdupois.
10 myr'igrams	make one quin'tal	= 220.46 pounds avoirdupois.
10 quin'tals	make one TON'NE (T.)	= 2,204.6 pounds avoirdupois.

The *gram* is derived from the Greek *gramma*, a *rule* or *standard*, and is equal to a cubic *centimeter* of distilled water in a vacuum, at its greatest density, that is, at the temperature of 4° by the centigrade thermometer, or 39.2° Fahrenheit.

The common unit for weighing groceries and coarse articles is the *kil-*

* United States gallons.

ogramme, which is equal to 2.2046 pounds avoirdupois, as shown by the table above.

METRIC NOTATION AND NUMERATION.

12. TO EXPRESS METRIC WEIGHTS AND MEASURES DECIMALLY, IN TERMS OF ANY GIVEN DENOMINATION, we give the following

Rule.

Write the several denominations one after another in their order, and place a decimal point between the given denomination and those below it.

Example.—Express 7 myriameters, 5 kilometers, 0 hectometers, 2 dekameters, 3 meters, 4 decimeters, 8 centimeters, and 9 millimeters, in terms of a meter.

Analysis.—As we have seen, the metric system is founded upon the Arabic notation, the denominations of the former corresponding with the orders of the latter. Hence, metric weights and measures, like our United States money, are written as whole numbers and decimals of the denomination which is taken for the unit, as in the following—

Table.

Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.	Tenths.	Hundredths.	Thousandths.
M.	Km.	Hm.	Dm.	M.	dm.	cm.	mm.
7	5	0	2	3	4	8	9

The result is 75023.489 meters. If expressed in centimeters the answer will be 7502348.9 centimeters; if in kilometers the answer will be 75.023489.

Should any intervening denominations be omitted in the given number their places must be supplied by *ciphers*.

As each denomination in square measure occupies *two places* of figures, in writing *square* decimeters, &c., as *decimals*, if the number is *less* than 10 a *cipher* must be prefixed to the figure denoting them. Thus, 13 square meters and 5 square decimeters = 13.05 square meters.

In like manner, in writing *cubic* decimeters, &c., as *decimals*, if the number is *less* than 10, *two ciphers* must be prefixed to it. Thus, 25 cubic meters and 3 cubic decimeters = 25.003 cubic meters.

Hence, metric weights and measures expressed in terms of a single denomination, are read in the same manner as *whole numbers* and *decimals*.

REDUCTION OF METRIC WEIGHTS AND MEASURES.

13. TO REDUCE HIGHER METRIC DENOMINATIONS TO LOWER, we have the following

Rule.

Multiply the given denomination by 10, 100, 1000, &c., as the case may require, and point off as many figures for decimals as there are decimal places in both factors.

Example.—Reduce 75.4354 kilometers to meters.

Analysis.—Since it takes 10 of a *lower* denomination to make a *unit* of the next higher, it is plain that to reduce a higher denomination to the next lower, we must multiply it by 10; to reduce it to the next lower still, we must multiply it again by 10, and so on. But from kilometers to meters there are *three* denominations; we therefore multiply by 1,000, or remove the decimal point three places to the right. (See Thompson's New Practical Arithmetic, art. 181.)

OPERATION.
75.4354 km.
1000
75435.4000 m.

It should be remembered that in the metric system each denomination of *square* measure occupies the place of *two* figures; and each denomination of *cubic* measure, the place of *three* figures.

Reduce 35.25 hectares to square meters.

Reduce 450 kilograms to grammes.

Reduce 325.12 hectoliters to liters.

Reduce 1852 ars to square meters.

Reduce 2765 cubic meters to cubic decimeters.

Reduce 8426.75 kilograms to grams.

14. TO REDUCE LOWER METRIC DENOMINATIONS TO HIGHER, we have the following

Rule.

Divide the given denomination by 10, 100, 1000, &c., as the case may require, and move the decimal point as many places toward the left as there are ciphers in the divisor.

Example.—Reduce 65432.1 meters to kilometers.

Analysis.—Since it takes 10 lower units to make *one* of the next higher denomination, it follows that to change a term from a lower to the next higher denomination, it must be divided by 10; to change to the next higher still, it must be again divided by 10, and so on.

OPERATION.
1000)65432.1 m.
Ans. 65.4321 km.

From meters to kilometers there are three denominations; we therefore divide by 1000 or remove the decimal point *three* places to the left, as in the above operation.

Reduce 876543 square meters to hectars. (See table, p. 28.)

Reduce 39 meters to kilometers.

Reduce 3456.78 grammes to kilograms.

Reduce 93625.7 liters to kiloliters.

15. APPROXIMATE VALUES.

In comparing metric weights and measures with those now in use, the *approximate values* are often convenient. Thus, when no great accuracy is required, we may, for all practical purposes, consider—

One decimeter	= 4 inches.	One cu. met. or ster	= $1\frac{1}{2}$ cu. yd., or $\frac{1}{3}$ cord.
One meter	= 39.37 inches.	One liter	= 1 quart.
Five meters	= 1 rod.	One hectoliter	= $2\frac{1}{2}$ bushels.
One kilometer	= $\frac{1}{2}$ mile.	One gram	= $1\frac{1}{2}$ grains.
One square meter	= $10\frac{1}{4}$ square feet.	One kilogram	= $2\frac{1}{2}$ pounds.
One hectare	= $2\frac{1}{2}$ acres.	One millier, or ton	= 2200 pounds.

APPLICATION OF METRIC WEIGHTS AND MEASURES.

16. TO ADD, SUBTRACT, MULTIPLY, AND DIVIDE METRIC WEIGHTS AND MEASURES, we have the following

Rule.

Express the numbers decimaly, and proceed as in the corresponding operation of whole numbers and decimals.

Examples.

1. What is the sum of 7358.356 meters + 8.614 hectometers + .95 millimeters?

Solution.—7358.356 m. + 861.4 m. + .095 = 8219.851 m. *Ans.*

Or it may be stated thus:

$$\begin{array}{r} 7358.356 \\ 861.4 \\ .095 \\ \hline 8219.851 \end{array}$$

8219.851. *Ans.*

2. What is the difference between 8.5 kilograms and 976 grammes?

Solution.—8.5 — .976 = 7.524 kilos. *Ans.*

Or it may be stated thus:

$$\begin{array}{r} 8.500 \text{ kilos.} \\ .976 \text{ kilo.} \\ \hline 7.524 \text{ kilos.} \end{array}$$

7.524 kilos. *Ans.*

3. How much silk is there in 12 $\frac{1}{2}$ pieces, each containing 48.75 meters?

Solution.—48.75 m. \times 12.5 = 609.375 m. *Ans.*

Or it may be stated thus:

$$\begin{array}{r} 48.75 \\ 12.5 \\ \hline 24375 \\ 9750 \\ 4875 \\ \hline 609.375 \text{ m.} \end{array}$$

609.375 m. *Ans.*

4. How many suits, each containing 5.68 meters, can be made from 426 meters of cloth?

Solution.—426 \div 5.68 m. = 75 suits. *Ans.*

Or it may be stated thus:

$$\begin{array}{r} 5.68 \mid 426.00 \text{ (75 suits. Ans.)} \\ 3976 \\ \hline 2840 \\ 2840 \\ \hline 0 \end{array}$$

17. TO REDUCE METRIC TO COMMON WEIGHTS AND MEASURES, we have the following

Rule.

Multiply the value of the principal unit of the table by the given metric number; but before multiplying, the metric number should be reduced to

the same denomination as the *principal* unit, whose value is taken for the multiplicand.

Example.—Reduce 5.6 meters to inches.

Analysis.—Since there are in one meter 39.37 inches, in 5.6 meters there are 5.6 times 39.37 in.—

$$\begin{array}{r} 39.37 \text{ in.} \\ 5.6 \text{ in.} \\ \hline 23622 \\ 19685 \\ \hline 220.472 \text{ in.} \end{array}$$

220.472 in. *Ans.*

In 45 kilograms how many pounds?

Solution.—45 kilos \times 2.2046 = 99.2070 lbs. *Ans.*

Or it may thus be stated:

$$\begin{array}{r} 2.2046 \\ 45 \\ \hline 110230 \\ 88184 \\ \hline 99.2070 \text{ lbs.} \end{array}$$

99.2070 lbs. *Ans.*

In 63 kilometers, how many miles? (See *Table of linear measure*, p. 28.)

Reduce 75 liters to gallons. (See *Table of dry and liquid measure*, p. 29.)

Reduce 56 dekaliters to bushels. (See *Table of dry and liquid measures*, p. 29.)

Reduce 120 grams to ounces. (See *Table of weights*, p. 29.)

Reduce 137.75 kilograms to pounds. (See *Table of weights*, p. 29.)

In 36 *ares*, how many square rods?

Analysis.—Since there are 119.6 square yards in one *ar*, in 36 *ars* there are 36 times 119.6 square yards. Now, 119.6 \times 36 = 4305.6 square yards, and 4305.6 square yards \div 30 $\frac{1}{4}$ square yards = 142.33 square rods. *Ans.*

In 60.25 hectares, how many acres?

In 120 cubic meters, how many cubic feet?

18. TO REDUCE COMMON TO METRIC WEIGHTS AND MEASURES, we have the following

Rule.

Divide the given number by the value of the principal metric unit of the table.

Before dividing, however, the given number should be reduced to the lowest denomination it contains; then to the denomination in which the value of the principal unit is expressed.

Example.—Reduce 213 feet 4 inches to meters.

Analysis.—213 feet 4 inches = 2560 inches. Now, OPERATION. in 39.37 inches there is one meter; therefore, in 2560 39.37)2560.00 in. inches there are as many meters as 39.37 inches contained times in 2560; hence, 2560 \div 39.37 = 65.02 *Ans.* 65.02 + m. meters.

In 63 $\frac{1}{3}$ yards, how many meters?

In 13750 pounds, how many kilograms?

In 250 quarts, how many liters?

In 2056 $\frac{1}{4}$ bushels, how many kiloliters?

The following are compact tables by Prof. Persifor Frazer, jr., together with examples of their use:

[Some tables for the interconversion of metric and english units.]

BY PERSIFOR FRAZER, JR., A. M.

[Read before the American Philosophical Society, April 5, 1878.]

Captain Kater, in 1821, as a member of the Royal Standard's Commission, appointed in 1818, made the determination of the meter to be 39.37079 inches. This was adopted by the commission and was embodied into the statute of the British Parliament enacted in 1824, establishing the platinum standard meter in Paris as in length equal to 39.3708 inches of brass at the temperature of 62° Fahrenheit, the platinum standard being at 0° centigrade, or 32° Fahrenheit, the temperature of melting ice.

Captain Kater's value was again sanctioned by law in 1864.* In 1866, the Royal Ordnance Survey adopted 1 meter = 39.370432 inches, on the authority of Col. (then Captain) A. R. Clarke, superintendent of the office of the survey at Southampton.

In 1869, the more recent Royal Standard's Commission, under the presidency of Astronomer Royal Airey, reported comparative tables, founded on Kater's value, which were published in a parliamentary blue book, and may be found at the end of the second report of the Royal Standard's Commission, published in that year.†

The subjoined work was undertaken to supply a want which every physicist and chemist, and, indeed, very many artisans and manufacturers have felt, for a set of convenient and consistent tables for converting various values of measure and weight from one into the other of the two systems between which at present the calculations of the greater part of the civilized world, both in science and in trade, are divided.

Every one knows that a multitude of tables for this object are already in existence, yet it must be apparent to any one who has compared them together that there are generally discrepancies between them.

For instance, three authorities which should command the confidence of scientific men gave the following values:

	Rankine.	Crookes.	Eliot and Stover.
Grains in a gram	15.43235	15.438395	15.4346
Cubic meters in 1 cubic foot	0.0283153	0.028314	.....
Tonnes in a ton	1.01605	1.015649	.....
Kilos per square centimeter in one pound per square inch	.0703095	.0702774	.....

Only three authorities are here quoted, but the number might be almost indefinitely increased. It is true that for most purposes these differences, being less than one hundredth of one per cent., would not seriously affect the results; but there are problems continually occurring where some recognized equivalent is most desirable, and still a greater number where it is desirable that all the diverse terms employed should have been obtained from the same original unit and by the same methods.

It would be far better that all the English-speaking world should accept a wrong determination as the only legal one than that each person who employs such reciprocal values should take a different standard, even if one of the number could be absolutely right.

In all questions relating to the value of linear, superficial, and cubical equivalents of the English and metric units, including those defined by law as a certain whole number and fraction of cubic inches or feet (e. g. the bushel, barrel, stone-perch, &c.), the determination of Kater has been taken and squared, cubed, multiplied, and divided until the expression for the desired derivative of the meter was obtained in terms of some derivative of the inch, no decimals having been omitted until the final number was reached; when the shorter approximate expression has been substituted by an application of the well-known rules governing such cases.

The number of decimal places given has been in proportion to the importance of the unit as a base from which to calculate other values. Thus the number of places in the grain-gram equivalents is eleven (as in the report of Mr. Upton, from which it was taken), whilst the rood-ar, being less frequently used and especially being of less im-

* When the use of the metric system was rendered permissive in Great Britain so far as related to contracts.

† Extracts from a private letter from President F. A. P. Barnard, of Columbia College, New York.

portance as a base from which to derive other values, is given in five and six places, respectively.

This method of separate calculation from the fundamental inch-meter value has been employed for each of the above-mentioned kinds of dimensions, and the value of the metric unit in the inch derivative has been converted into the reciprocal or inch derivative unit by simply dividing the whole decimal into one and shortening as before. This is obviously to be preferred to taking the reciprocal of the legal value of the meter in inches, as the base of the calculation.

Crookes (Select Method of Chemical Analysis) was drawn on for the form of expressing the Fahrenheit in the centigrade degree. Rankine is responsible for the statement of the relation between English heat units and French calories, but both have been verified.

In weight, the fundamental units (the value of the gram in grains) is taken from the report of Mr. Upton (chief clerk of the Treasury) to Hon. John Sherman, Secretary, March 26, 1878, and from this value all the others were calculated.

In fine, all the values here appended have been as carefully as possible revised by the author, and, in addition, have had the benefit of the very valuable criticism and corrections of Professor Chase, of Haverford College, and of President Barnard, of Columbia College, the latter of whom has conferred greater security in verifying them by the calculating machine.

In the case of linear units, four of those most constantly recurring were selected, and the values of one up to nine times each unit are given in terms of the other. This method, which is employed in Crookes' "Select Methods of Chemical Analysis" (London, 1871), permits any decimal multiple or fraction of one unit to be obtained with great accuracy in terms of the other, by a change of the decimal point and a simple addition.

Thus, if it be required to find the number of inches in 348 $\frac{1}{2}$ centimeters, the fraction would first be written decimal, 348.16. The value in inches of three centimeters is 1.181124.

	Inches.
300 centimeters would equal	118.1124
40 centimeters would equal	15.74832
8 centimeters would equal	3.149663
0.1 centimeters would equal	0.03937079
0.06 centimeters would equal	0.02362247
348.16 centimeters would equal	137.07337626

For area, capacity, and weight, the value of only one unit of each is given in terms of the other, and a simple multiplication will give any number of times such an unit.

The value of the meter in inches is given by Mr. Upton, chief clerk of Treasury Department, in the report before mentioned, as 39.370432, and, consequently, the values here given do not agree with those for length, area, surface, or capacity in that report.

The same unit which he gives for the gram in grains is adopted here, so that the column of weights should accord.

Tables for the interconversion of English and metric units.

By PERSIFOR FRAZER, Jr., A. M.

[Presented to Am. Philosophical Society, April 5, 1878.]

1 cubic inch water weighs = 252.7574 grains.
 At max. dens. bar. 30 in., air 62° F. (Barnard).
 1 cubic foot water weighs = 62.3949696 lbs.
 1 cwt. (12 lbs.) = 50.80233 kilos.
 Quarter (28 lbs.) = 12.700555 " " "
 Drachm = 1.77185 grams.

LINEAL UNITS.

Inches.	Centimeters.	Feet.	Meters.
0.393709	= 1	3.2809	= 0.3047945
1	= 2.539954	2	= 1
0.787416	= 2	5.0799	= 0.6095890
2	= 6.5618	3	= 2
1.181124	= 3	7.6199	= 0.9143835
3	= 9.8427	4	= 3
1.574832	= 4	10.1598	= 12.191780
4	= 13.1236	5	= 4
1.968539	= 5	12.6998	= 15.9239724
5	= 16.4045	6	= 5
2.362247	= 6	19.6854	= 6
6	= 15.2397	7	= 2.1335614
2.755955	= 7	22.9963	= 7
7	= 17.7797	8	= 2.4383559
3.149663	= 8	20.3196	= 8
8	= 26.2472	9	= 2.7431504
3.543371	= 9	29.5281	= 9
9	= 22.8566		

LINEAL UNITS.

Yards.	Meters.	Miles.	Kilometers.
1	= 0.9143835	0.6214	= 1
1.093633	= 1	1	= 1.0903
2	= 1.8287669	1.2428	= 2
2.1873	= 2	2	= 3.2186
3	= 2.7431504	1.8641	= 3
3.2809	= 3	3	= 4.8279
4	= 3.6375340	2.4855	= 4
4.3745	= 4	4	= 6.4373
5	= 4.5719174	3.1069	= 5
5.4682	= 5	5	= 8.0466
6	= 5.4963009	3.7283	= 6
6.5658	= 6	6	= 9.6559
7	= 6.4606845	4.3497	= 7
7.6554	= 7	7	= 11.2652
8	= 7.315068	4.9711	= 8
8.7491	= 8	8	= 12.8745
9	= 8.2294514	5.5924	= 9
9.8427	= 9	9	= 14.4838

AREA.

Sq. inch.	Sq. centimeter.	Sq. feet.	Sq. meter.
1	= 6.451367	1	= 0.09290
0.1550059	= 1	10.76393	= 1
Sq. yard.	Sq. meter.	Sq. yard.	Ar.
1	= 0.8360972	1	= 0.00836097
1.19603326	= 1	119.603326	= 1
Rood.	Are.	Acre.	Hectar.
1	= 10.11678	1	= 0.404671
0.098845	= 1	2.471143	= 1

THERMOMETER.		HEAT UNITS.		CALORIES.	
Fahrenheit degrees.	Centigrade degrees.	1 lb. water, 1 kilogram	1° Fah. water, 1° Cent.	1° Fah. water, 1° Cent.	
1	= 0.55556	3.96832	= 1	1	
1.8	= 1	1	= 0.251996		

CAPACITY.			
<i>Cubic inches.</i>	<i>Cubic centimeters.</i>	<i>Cubic foot.</i>	<i>Cubic decimeter (liter).</i>
1	= 16.38617589	1	= 28.315312
0.06102705152	= 1	0.03531658	= 1
<i>Cub. ft.</i>	<i>Cub. m. (stere).</i>	<i>Cubic yard.</i>	<i>Cubic meter (stere).</i>
1	= 0.028315	1	= 0.764513470
35.31658	= 1	1.3680215	= 1
<i>Minim.</i>	<i>Cub. cent. M.</i>	<i>Fluid oz.</i>	<i>Cub. cent. M.</i>
1	= 0.0616082	1	= 29.5719289
16.23158	= 1	0.033815	= 1
<i>U. S. pint</i>	<i>Liter.</i>	<i>U. S. gal.</i>	<i>Liter.</i>
<i>(wine)</i>		1	= 3.7852067
2.1134908	= 1	0.264186	= 1
<i>U. S. wine bl.</i>	<i>Liter.</i>	<i>Gal. (imp.).</i>	<i>Liter.</i>
<i>(31.5 gals.)</i>		1	= 4.54345728
0.00838686	= 1	0.2200967	= 1
<i>U. S. bush.</i>	<i>Liter.</i>	<i>Cord.</i>	<i>Stere (cubic meter).</i>
<i>(2150.42 cu. in.)</i>		1	= 35.2371556
0.028379135	= 1	0.275911	= 1
<i>Solid perch</i>	<i>(25 cub. ft.)</i>	<i>Cubic meter (ster).</i>	
	1	= 0.7078828	
	1.412663	= 1	

WEIGHT.

<i>Lbs. to</i>	<i>Kilos to</i>	<i>Pounds to</i>	<i>Kilos to sq. centimeter.</i>
<i>foot.</i>	<i>meter.</i>	<i>sq. inch.</i>	<i>centimeter.</i>
1	= 1.48819	1	= 0.703096
0.6719572	= 1	14.22282	= 1
<i>Grains.</i>	<i>Grams.</i>	<i>Lbs. (av.).</i>	<i>Kilogrammes.</i>
1	= 0.06479895036	1	= 0.453592653
15.43234874	= 1	2.2046212	= 1
<i>Oz. (av.).</i>	<i>Grammes.</i>	<i>Lbs. (troy).</i>	<i>Kilogrammes.</i>
1	= 28.349541	1	= 0.373241954
0.035274	= 1	2.679227	= 1
<i>Tons.</i>		<i>Tonnes (1000 kilos).</i>	
Long (2240 lbs.)		1.0160475	
Short (2000 lbs.)		0.9071853	
Long. 0.9842059	{	=	
Short. 1.1023106	{	1	
<i>Grs. per</i>	<i>Milligrams</i>	<i>Foot.</i>	<i>Kilogram-</i>
<i>U. S. gallon.</i>	<i>per liter.</i>	<i>lbs.</i>	<i>eter.</i>
1	= 17.1189987	1	= 0.138253
0.05341463	= 1	7.23314	= 1

METRIC SYSTEM.

CONCLUSION.

The grand object of this metrological reform may be stated in three words: 1. *Uniformity*; 2. *Permanency*; 3. *Universality*.

The nomenclature of the metric system we consider is not only unrivaled in respect to precision, significance, brevity, and completeness, but being derived from the two ancient classic languages, it becomes cosmopolitan in character. As soon as the values of the four base units are fixed in the mind, the values of all the *derivative units*, being formed by *multiplying or dividing the base by ten*, are at once apprehended.

From the survey we have been able to make of the more recent progress of this metrological reform in the more civilized and enlightened portions of the globe, we are irresistibly led to the conclusion that the metric system of weights and measures is destined to become in the near future universal among all the civilized nations of the world. Its adoption in the United States, and its obligatory use in all the government departments, is believed to be by many a fixed fact at no very distant day. As an earnest of this fact, we call your attention to the accompanying reports of the several heads of the executive departments of the government, as to the periods of time it would be advisable to adopt the system in their several bureaus.

Why, then, we would most respectfully inquire, should this country longer remain indifferent to its adoption, when our commercial relations with France, the Germanic Empire, Portugal, Belgium, Holland, Spain, Italy, Austria, Turkey, Sweden, Romania, Moldavia, Wallachia, Switzerland, Denmark, Greece, Mexico, and the South American States, and their dependencies or colonies; countries which have already adopted the metric system exclusively, render it necessary in our intercourse with these nations to use this system in all our sales and purchases? The magnitude of these transactions in commerce, and the intimate social relations between these peoples and the United States, combine to render the early adoption of the system in this country imperative.

Quite fifty years ago, when this system of metrology was struggling for existence in the country which gave it birth, John Quincy Adams said of it:

The French system embraces all the great and important principles of uniformity which can be applied to weights and measures. * * * It is a system adapted by the highest efforts of human science, ingenuity, and skill, to the common purposes of all. Considered merely as a labor-saving machine, it is a new power offered to man, incomparably greater than that which he has acquired by the agency which he has given to steam. It is in design the greatest *invention* of human ingenuity since that of printing. * * * Its universal establishment would be a universal blessing.

Indeed, the metric system has received the support of statesmen and the earnest sanction of scientists both in the New and the Old World for the past half century or more; and we cannot therefore longer treat with indifference the numerous appeals that are being made to Congress, from time to time, by the scientific and business men of the country, urging the adoption of the system in such departments of the government, at least, as have the largest relations with those countries and nations which have already adopted it in whole or in part, as an earnest of our purpose to adopt it in whole in all government transactions, so soon as our people are educated up to that point in its use that they will prefer the new to the existing system.

At the last session of Congress upwards of \$17,000 was appropriated for rent of buildings for the safe-keeping and preservation of finished weights, measures, balances, and metric standards, and to meet treaty obligations arising from a convention for the establishment and main-

tenance of an international bureau of weights and measures at or near Paris, France; and further, to utilize the standard metric weights and measures furnished the several States, by act of Congress.

To encourage the adoption of the metric system the committee recommended the passage of the following bill, namely:

A bill to enable importers to use the metric weights and measures.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the ad quantum duties upon all articles imported from foreign countries which are invoiced according to the weights and measures of the metric system shall be levied, collected, and paid at rates appropriate to the weights and measures of said system; that is to say:

The rate per gramme shall be 3.5 per cent. of the rate per ounce avoirdupois, or 3.2 per cent. of the rate per ounce troy.

The rate per kilogramme shall be two and two-tenths times the rate per pound.

The rate per metric ton shall be twenty-two times the rate per hundred pounds, or nineteen and six-tenths times the rate per hundred and twelve pounds, or 98 per cent. of the rate per twenty-two hundred and forty pounds.

The rate per lineal meter shall be 109 per centum of the rate per lineal yard.

The rate per square meter shall be 119 per cent. of the rate per square yard, or ten and seven-tenths times the rate per square foot.

The rate per hundred square meters shall be 107 per cent. of the rate per thousand square feet.

The rate per liter shall be 26 per cent. of the rate per gallon.

The rate per hectoliter shall be two and eight-tenths times the rate per bushel.

The rate per cubic meter shall be one and three-tenths times the rate per cubic yard, or thirty-five times the rate per cubic foot: *Provided*, That when by any provision of law the duties which are to be levied, collected, and paid shall be more or less than the duties and rates imposed in the statutory schedule, such provision of law shall be applied in the calculation of the rate to be imposed on the metric denomination: *And provided further*, That when the calculated rate exceeds \$1, the fraction of a cent, if any, shall be rejected; when it exceeds ten cents, the fraction of a mill, if any, shall be rejected; and in all cases a fraction of less than one-tenth of a mill shall be rejected.

SEC. 2. That the quantity of weight, gauge, or measure stated in the return of any weigher, gauger, or measurer employed in the service of the customs revenue may be stated in metric denominations; and, if not so stated, shall be reducible to such denominations according to the equivalents set forth in section 3570 of the Revised Statutes.

This bill makes a slight difference in favor of the metric system by avoiding awkward fractions that would result from using the table of equivalents given in the Revised Statutes. The advantage thus given is sufficient, it is believed, to induce importers to use the metric system in their invoices, and we have no doubt that it would result in materially promoting the adoption of the system. It would have the effect in course of time to familiarize our merchants all over the country with it, and thus the way would be made for more radical measures for its adoption.

Respectfully submitted.

ALEXANDER H. STEPHENS,
Chairman.

LEVI MAISH,
ROBT. B. VANCE,
JOHN B. CLARK, JR. (MISSOURI),
R. M. KNAPP,
H. L. MULDROW,
JOHN B. CLARKE (KENTUCKY),
M. S. BREWER,
THOS. RYAN,
J. W. DWIGHT,
R. L. GIBSON,

Committee on Coinage, Weights, and Measures.

CHAPTER II.

Message from the President of the United States, transmitting a report of a metric convention between the United States and certain foreign governments, signed at Paris on the 20th of May, 1875.

MARCH 10, 1876.—Read; convention read the first time, referred to the Committee on Foreign Relations, and, together with the accompanying papers, ordered to be printed in confidence for the use of the Senate.

WASHINGTON, March 10, 1876.

To the Senate of the United States:

I transmit to the Senate for consideration, with a view to ratification, a metric convention between the United States and certain foreign governments, signed at Paris, on the 20th of May, 1875, by Mr. E. B. Washburne, the minister of the United States at that capital, acting on behalf of this government, and by the representatives acting on behalf of the foreign powers therein mentioned.

A copy of certain papers on the subject, mentioned in the subjoined list, is also transmitted for the information of the Senate.

U. S. GRANT.

List of accompanying papers.

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CONVENTION.

His Excellency the President of the United States of America, His Majesty the Emperor of Germany, His Majesty the Emperor of Austria and Hungary, His Majesty the King of the Belgians, His Majesty the Emperor of Brazil, His Excellency the President of the Argentine Confederation, His Majesty the King of Denmark, His Majesty the King of Spain, His Excellency the President of the French Republic, His Majesty the King of Italy, His Excellency the President of the Republic of Peru, His Majesty the King of Portugal and the Algarves, His Majesty the Emperor of all the Russias, His Majesty the King of Sweden and Norway, His Excellency the President of the Swiss Confederation, His Majesty the Emperor of the Ottomans, and His Excellency the President of the Republic of Venezuela—

Desiring the international uniformity and precision in standards of weight and measure, have resolved to conclude a convention to this effect, and have named as their plenipotentiaries the following:

His Excellency the President of the United States of America: Mr. Elihu Benjamin Washburne, Envoy Extraordinary and Minister Plenipotentiary of the United States at Paris;

His Majesty the Emperor of Germany: His Highness Prince Hohenlohe Schillingsfurst, Grand Cross of the Order of the Red Eagle of Prussia, and of the Order of St. Hubert of Bavaria, &c., &c., &c., His Ambassador Extraordinary and Plenipotentiary at Paris;

His Majesty, the Emperor of Austria-Hungary: His Excellency Count Apponyi, His Actual Chamberlain and Privy Counselor, Knight of the Golden Fleece, Grand Cross of the Royal Order of St. Stephen of Hungary, and of the Imperial Order of Leopold, &c., &c., His Ambassador Extraordinary and Plenipotentiary at Paris;

His Majesty the King of the Belgians: Baron Bergens, Grand Officer of his Order of Leopold, Grand Officer of the Legion of Honor, &c., &c., &c., His Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Majesty the Emperor of Brazil: Mr. Marcus Antonio d'Aranjo, Viscount d'Itajuba, Grandee of the Empire, Member of his Majesty's Council, Commander of His Order of Christ, Grand Officer of the Legion of Honor, &c., &c., &c., His Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Excellency the President of the Argentine Confederation: M. Balcarce, Envoy Extraordinary and Minister Plenipotentiary of the Argentine Confederation at Paris;

His Majesty the King of Denmark: Count de Moltke-Hoitfeldt, Grand Cross of the Order of Danebrog, and Decorated with the Cross of Honor of the same Order, Grand Officer of the Legion of Honor, &c., &c., &c., His Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Majesty the King of Spain: His Excellency Don Mariano Roca de Tegores, Marquis of Molins, Viscount de Rocamora, Grandee of Spain of the First Class, Knight of the Renowned Order of the Golden Fleece, Grand Cross of the Legion of Honor, &c., &c., &c., Director of the Royal Spanish Academy, His Ambassador Extraordinary and Plenipotentiary at Paris; and General Ibañez, Grand Cross of the Order of Isabella the Catholic, &c., &c., Director General of the Geographical and Statistical Institute of Spain, Member of the Academy of Sciences;

His Excellency the President of the French Republic: The Duke Decazes, deputy to the National Assembly, Commander of the Order of the Legion of Honor, &c., &c., &c., Minister of Foreign Affairs; the Viscount de Meaux, deputy to the National Assembly, Minister of Agriculture and of Commerce; and M. Dumas, Perpetual Secretary to the Academy of Sciences, Grand Cross of the Order of the Legion of Honor;

His Majesty the King of Italy: The Chevalier Constantino Nigra, Knight of the Grand Cross of his Orders of St. Maurice and St. Lazarus, and of the Crown of Italy, Grand Officer of the Legion of Honor, &c., &c., &c., his Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Excellency the President of the Republic of Peru: M. Pedro Galvez, Envoy Extraordinary and Minister Plenipotentiary of Peru at Paris; and M. Francisco de Rivero, formerly Envoy Extraordinary and Minister Plenipotentiary of Peru;

His Majesty the King of Portugal and of the Algarves: M. José de Silva Mendes Seal, Peer of the Realm, Grand Cross of the Order of Saint James, Knight of the Order of the Tower, and Sword of Portugal, &c., &c., &c., his Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Majesty the Emperor of all the Russians: M. Gregory O'Konneff, Knight of the Russian Orders of St. Anne of the first class, of St. Stanislaus of the first class, of St. Vladimir of the third, Commander of the Legion of Honor, Actual Counselor of State, Counselor of the Embassy of Russia at Paris;

His Majesty the King of Sweden and Norway: Baron Adelswärd, Grand Cross of the Order of the Polar Star of Sweden, and of St. Olaf of Norway, Grand Officer of the Legion of Honor, &c., &c., &c., his Envoy Extraordinary and Minister Plenipotentiary at Paris;

His Excellency the President of the Swiss Confederation: M. Jean Conrad Kern, Envoy Extraordinary and Minister Plenipotentiary of the Swiss Confederation at Paris;

His Majesty the Emperor of the Ottomans: Hussey Bey, Lieutenant-Colonel of Staff, wearer of a fourth-class decoration of the Imperial Order of Osmania, of a fifth-class decoration of the Order of Medjidie, Officer of the Legion of Honor, &c., &c., &c.;

His Excellency the President of the Republic of Venezuela: Doctor Eliseo Acosta, Who, after having exhibited their full powers, which were found to be in good and due form, have agreed upon the following articles:

ARTICLE 1.

The high contracting parties engage to establish and maintain, at their common expense, a scientific and permanent international bureau of weights and measures, the location of which shall be at Paris.

ARTICLE 2.

The French Government shall take all the necessary measures to facilitate the purchase, or, if expedient, the construction of a building, which shall be especially devoted to this purpose, subject to the conditions stated in the regulations, which are subjoined to this convention.

ARTICLE 3.

The operation of the international bureau shall be under the exclusive direction and supervision of an international committee of weights and measures, which latter shall be under the control of a general conference for weights and measures, to be composed of the delegates of all the contracting governments.

ARTICLE 4.

The general conference for weights and measures shall be presided over by the president, for the time being, of the Paris Academy of Sciences.

ARTICLE 5.

The organization of the bureau, as well as the formation and the powers of the international committee, and of the general conference for weights and measures, are established by the regulations subjoined to this convention.

ARTICLE 6.

The international bureau of weights and measures shall be charged with the following duties:

- 1st. All comparisons and verifications of the new prototypes of the meter and kilogram.
- 2d. The custody of the international prototypes.
- 3d. The periodical comparison of the national standards with the international prototypes and with their test copies, as well as comparisons of the standard thermometers.
- 4th. The comparison of the prototypes with the fundamental standards of non-metrical weights and measures used in different countries for scientific purposes.
- 5th. The standardizing and comparison of geodesic measuring-bars.
- 6th. The comparison of standards and scales of precision, the verification of which may be requested by governments or scientific societies, or even by constructors or men of science.

ARTICLE 7.

The persons composing the bureau shall be a director, two assistants, and the necessary number of employees. When the comparisons of the new prototypes shall have been finished, and when these prototypes shall have been distributed among the different states, the number of persons composing the bureau shall be reduced so far as may be deemed expedient.

The governments of the high contracting parties will be informed by the international committee of the appointment of persons composing this bureau.

ARTICLE 8.

The international prototypes of the meter and of the kilogram, together with the test copies of the same, shall be deposited in the bureau, and access to them shall be allowed to the international committee only.

ARTICLE 9.

The entire expense of the construction and outfit of the international bureau of weights and measures, together with the annual cost of its maintenance and the expenses of the committee, shall be defrayed by contributions from the contracting states, the amount of which shall be computed in proportion to the actual population of each.

ARTICLE 10.

The amounts representing the contributions of each of the contracting states shall be paid at the beginning of each year, through the ministry of foreign affairs of France, into the Caisse de dépôts et consignations at Paris, whence they may be drawn as occasion may require, upon the order of the director of the bureau.

ARTICLE 11.

Those governments that may take advantage of the privilege, which is open to every state, of acceding to this convention, shall be required to pay a contribution, the amount of which shall be fixed by the committee on the basis established in article 9, and which shall be devoted to the improvement of the scientific apparatus of the bureau.

ARTICLE 12.

The high contracting parties reserve to themselves the power of introducing into the present convention, by common consent, any modifications the propriety of which may have been shown by experience.

ARTICLE 13.

At the expiration of twelve years this convention may be abrogated by any one of the high contracting parties, so far as it is concerned. Any government that may avail itself of the right of terminating this convention, so far as it is concerned, shall be required to give notice of its intentions one year in advance, and by so doing shall renounce all rights of joint ownership in the international prototypes and in the bureau.

ARTICLE 14.

This convention shall be ratified according to the constitutional laws of each state, and the ratifications shall be exchanged at Paris within six months, or sooner, if possible.

It shall take effect on the 1st day of January, 1876.

In testimony whereof the respective plenipotentiaries attached their signatures and have thereunto affixed their seals of arms.

Done at Paris, May 20, 1875.

[L. S.]

E. B. WASHBURN.

[L. S.]

HOHENLOHE.

[L. S.]

APPONYI.

[L. S.]

BERGENS.

[L. S.]

VISCOUNT DE ITAJUBA.

[L. S.]

M. BALCARCE.

[L. S.]

MOLTKE-HOITFELDT.

[L. S.]

MARQUIS DE MOLINS.

[L. S.]

CARLOS IBANEZ.

[L. S.]

DECAZES.

[L. S.]

C. DE MEAUX. }

[L. S.]

N. DUMAS.

[L. S.]

NIGRA.

[L. S.]

P. GALVEZ.

[L. S.]

FRANSE DE RIVERO.

[L. S.]

JOSÉ DE SILVA MENDESSEAL.

[L. S.]

O'KONNEFF,

[L. S.]

For BARON ANDELSWARD, (prevented).

H. AKERMAN.

[L. S.]

KERN.

[L. S.]

HUSSEY.

[L. S.]

E. ACOSTA.

[Appendix No. 1.]

REGULATIONS.

ARTICLE 1.

The international bureau of weights and measures shall be established in a special building, possessing all the necessary safeguards of stillness and stability.

It shall comprise, in addition to the vault, which shall be devoted to the safe-keeping of the prototype, rooms for mounting the comparators and balances, a laboratory, a library, a room for the archives, work-rooms for the employés, and lodgings for the watchmen and attendants.

ARTICLE 2.

It shall be the duty of the international committee to procure a suitable building and to adapt it to the purposes designated. In case of the committee's inability to obtain a suitable building, one shall be built under its directions and in accordance with its plans.

ARTICLE 3.

The French Government shall, at the request of the international committee, take the necessary measures to cause the bureau to be recognized as an establishment of public utility.

ARTICLE 4.

The international committee shall cause the necessary instruments to be constructed, such as comparators for the standards of line and end measures, apparatus for the

determination of absolute dilatations, balances for weighing in air and in vacuo, comparators for geodetic measuring bars, &c.

ARTICLE 5.

The entire expense incurred in the purchase or construction of the building, and in the purchase and placing of the instruments and apparatus, shall not exceed 400,000 francs.

ARTICLE 6.

The estimate of annual expenditures is as follows:

(A) For the first period, i. e., during the construction and comparison of the new prototypes—	
(a) Salary of the director	15,000 fr.
of two adjuncts, at 6,000 fr. each	12,000 fr.
of four assistants, at 3,000 fr. each	12,000 fr.
Pay of doorkeeper (mechanic)	3,000 fr.
Wages of two office-boys, at 1,500 fr. each	3,000 fr.
	45,000 fr.
Total for salaries	45,000 fr.

(b) Compensation to men of science and artists who, by direction of the committee, may be employed to perform special duties, keeping of the building in proper order, purchase and repair of apparatus, fuel, light, and office expenses	24,000 fr.
(c) Compensation of the secretary of the international committee for weights and measures	6,000 fr.

Total	75,000 fr.
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The annual budget of the bureau may be modified by the international committee as necessity may require, at the suggestion of the director, but it shall in no case exceed the sum of 100,000 francs.

The contracting governments shall be notified of any modifications that the committee may think proper to make within these limits in the annual budget fixed by the present regulations.

The committee may authorize the director, at his request, to make transfers from one subdivision of the budget to another.

(B) For the period subsequent to the distribution of the prototypes :	
(a) Salary of the director	15,000 fr.
one adjunct	6,000 fr.
Pay of a doorkeeper (mechanic)	3,000 fr.
Wages of an office-boy	1,500 fr.
	25,500 fr.
(b) Office expenses	18,500 fr.
Compensation of secretary international committee	6,000 fr.
	50,000 fr.
Total	50,000 fr.

ARTICLE 7.

The general conference mentioned in article 3 of this convention shall be at Paris upon the summons of the international committee, at least once every six years.

It shall be its duty to discuss and initiate measures necessary for the dissemination and improvement of the metrical system, and to pass upon such new fundamental metrological determinations as may have been made during the time when it was not in session. It shall receive the report of the international committee concerning the work that has been accomplished, and shall replace one-half of the international committee by secret ballot.

The voting in the general conference shall be by states; each state shall be entitled to one vote.

Each of the members of the international committee shall be entitled to a seat at the meetings of the conference. They may at the same time be delegates of their governments.

ARTICLE 8.

The international committee mentioned in article 3 of the convention shall be composed of fourteen members, all of whom shall belong to a different state. It shall consist, at first, of the twelve members of the former permanent committee of the international commission of 1872, and of the two delegates who, at the time of the

appointment of that permanent committee, received the largest number of votes next to the members who were elected.

At the time of the renewal of one-half of the international committee, the retiring members shall be, first, those who, in cases of vacancy, may have been elected provisionally during the interval occurring between two sessions of the conference. The others shall be designated by lot. The retiring members shall be re-eligible.

ARTICLE 9.

The international committee shall direct the work connected with the verification of the new prototypes and, in general, all the metrological labors, as the high contracting parties may decide to have performed at the common expense. It shall, moreover, exercise supervision over the safe-keeping of the international prototypes.

ARTICLE 10.

The international committee shall choose its chairman and secretary by secret ballot. The governments of the high contracting parties shall be notified of the result of such elections.

The chairman and secretary of the committee and the director of the bureau must belong to different countries.

After having been formed, the committee shall hold no new elections and make no new appointments until three months after notice thereof shall have been given to all the members by the bureau of the committee.

ARTICLE 11.

Until the new prototypes shall have been finished and distributed, the committee shall meet at least once a year. After that time its meetings shall be held at least biennially.

ARTICLE 12.

Questions upon which a vote is taken in the committee shall be decided by a majority of the votes cast. In case of a tie, the vote of the chairman shall decide. No resolution shall be considered to have been duly adopted unless the number of members present be at least equal to a majority of the members composing the committee. Under this provision, absent members shall have the right to authorize members who are present to vote for them, and the members thus authorized shall furnish proper evidence of their authorization. The same shall be the case in elections by secret ballot.

ARTICLE 13.

During the interval occurring between two sessions, the committee shall have the right to discuss questions by correspondence. In such cases, in order that its resolutions may be considered to have been adopted in due form, it shall be necessary for all the members of the committee to have been called upon to express their opinions.

ARTICLE 14.

The international committee for weights and measures shall provisionally fill such vacancies as may occur in it; these elections shall take place by correspondence, each of the members being called upon to take part therein.

ARTICLE 15.

The international committee shall prepare detailed regulations for the organization and the labors of the bureau, and shall fix the amounts to be paid for the performance of the extraordinary duties provided for in article 6 of this convention.

Such amounts shall be applied to the improvement of the scientific apparatus of the bureau.

ARTICLE 16.

All communications from the international committee to the governments of the high contracting parties shall take place through the diplomatic representatives of such countries at Paris.

For all matters requiring the attention of the French authorities, the committee shall have recourse to the ministry of foreign affairs of France.

ARTICLE 17.

The director of the bureau and the adjuncts shall be chosen by the international committee by secret ballot.

The employés shall be appointed by the director. The director shall have a right to take part in the deliberations of the committee.

ARTICLE 18.

The director of the bureau shall have access to the place of deposit of the international prototypes of the meter and the kilogram only in pursuance of a resolution of the committee and in the presence of two of its members.

The place of deposit of the prototypes shall be opened only by means of three keys, one of which shall be in possession of the director of the archives of France, the second in that of the chairman of the committee, and the third in that of the director of the bureau. The standards of the class of national prototypes alone shall be used for the ordinary comparing work of the bureau.

ARTICLE 19.

The director of the bureau shall annually furnish to the committee: 1st. A financial report concerning the accounts of the preceding year, which shall be examined, and, if found correct, a certificate to that effect shall be given him; 2d. A report on the condition of the apparatus; 3d. A general report concerning the work accomplished during the course of the year just closed. The international committee shall make to each of the governments of the high contracting parties an annual report concerning all its scientific, technical, and administrative operations, and concerning those of the bureau.

The chairman of the committee shall make a report to the general conference concerning the work that has been accomplished since its last session.

The reports and publications of the committee shall be in the French language. They shall be printed and furnished to the governments of the high contracting parties.

ARTICLE 20.

The contributions referred to in article 9 of the convention shall be paid according to the following scale:

The number representing the population, expressed in millions, shall be multiplied by the coefficient three for states in which the use of the metrical system is obligatory; by the coefficient two for those in which it is optional; by the coefficient one for other states. The sum of the products thus obtained will furnish the number of units by which the total expense is to be divided. The quotient will give the amount of the unit of expense.

ARTICLE 21.

The expense of constructing the international prototypes, and the standards and test copies which are to accompany them, shall be defrayed by the high contracting parties in accordance with the scale fixed in the foregoing article.

The amounts to be paid for the comparison and verification of standards required by states not represented at this convention shall be regulated by the committee in conformity with rates fixed in virtue of article 15 of the regulations.

ARTICLE 22.

These regulations shall have the same force and value as the convention to which they are annexed.

(Signed)

E. B. WASHBURN.
HOHENLOHE.
APPONYI.
BERGENS.
VISCOUNT DE ITAJUBA.
M. BALCARCE.
MOLTKE-HOITFELDT.
MARQUIS DE MOLINS.
CARLOS IBÁÑEZ.
C. DE MEAUX.
DECAZES.
DUMAS.
NIGRA.
P. GALVEZ.
FRANCISCO DE RIVERO.
JOSE DE SILVA MENDESSEAL.
O'KONNEFF,
For BARON ADELSWARD (prevented)
H. AKERMAN.
KERN.
HUSSEY.
E. ACOSTA.

METRIC SYSTEM.

[Appendix No. 2.]

TRANSIENT PROVISIONS.

ARTICLE 1.

All states which are represented at the international metre commission which met at Paris in 1872, whether they are contracting parties to the present convention or not, shall receive the prototypes that they may have ordered, which shall be delivered to them in the condition guaranteed by the said international commission.

ARTICLE 2.

The principal object of the first meeting of the general conference of weights and measures shall be to sanction these new prototypes, and to distribute them among the states which shall have expressed a desire to receive them.

In consequence, the delegates of all the governments which were represented in the international commission of 1872, as likewise the members of the French section, shall, of right, form part of this first meeting for the sanction of the prototypes.

ARTICLE 3.

It shall be the duty of the international committee mentioned in Article 3 of the convention, and composed as provided in Article 8 of the regulations, to receive and compare the new prototypes one with the other, in accordance with the scientific decisions of the international commission of 1872, and of its permanent committee. Such modifications may, however, be made as may in future be suggested by experience.

ARTICLE 4.

The French section of the international commission of 1872 shall continue to have charge of the labors entrusted to it in the construction of the new prototypes, with the co-operation of the international committee.

ARTICLE 5.

The cost of manufacturing the metrical standards prepared by the French section shall be re-imburied by the governments interested, according to the cost-price per unit which shall be fixed by the said section.

ARTICLE 6.

The immediate formation of the international committee is authorized, and that body, when formed, is hereby empowered to make all necessary preparatory examinations for the carrying into effect of the convention, without, however, incurring any expense before the exchange of the ratifications of the said convention.

E. B. WASHBURN.
HOHENLOHE.
APPONYI.
BERGENS.
VISCOUNT DE ITAJUBA.
M. BALCARCE.
MOLTKE-HOITFELDT.
MARQUIS DE MOLINS.
CARLOS IBANEZ.
DECAZES.
C. DE MEAUX.
DUMAS.
NIGRA.
P. GALVEZ.
FRANCO. DE RIVERO.
JOSE DE SILVA MENDESSEAL.
O'KONNEFF.
For BARON ADELWARD, (prevented.)
H. AKERMAN.
KERN.
HUSSEY.
E. ACOSTA.

METRIC SYSTEM.

No. 3.

Mr. Hilgard to Mr. Fish.

WASHINGTON, December 13, 1872.

SIR: In pursuance of the notification received from the Department of State, under date of August 24, 1872, I attended the session of the International Standards Commission, (commission internationale du metre), held at Paris from the 24th of September until the 9th of October of this year, and I have the honor to submit to the Department a report of the labors of that commission to the present time.

In 1870, the Government of France invited the governments of other nations to send delegates to Paris, for the purpose of forming an international commission, having for its object the construction of new *metre* as an international standard of length; this new standard being intended to represent with the utmost attainable precision the actual legal metre, the *mètre des archives*, but satisfying more fully than the latter, by its material form and definition, the conditions of invariability and precision imposed by the present state of science upon a universal standard of reference.

The object of the commission being purely scientific, the President designated Prof. Joseph Henry and the present writer as delegates on the part of the United States, without diplomatic qualifications.

The first session, held on the 8th of August, 1870, was of short duration, the state of war between France and Germany preventing a full representation of interested nations. Professor Henry being at that time on a visit to Europe, attended that session, which resulted in the resolution, that instead of a single new standard, as many identical standards as there were nations represented should be constructed, one of their number being afterward chosen as the international standard, to be preserved in some place to be hereafter designated under the common care, while the others should be distributed to the participating countries.

The Government of France provided for the expenses of the proposed operations, it being understood that those governments who should afterward claim copies, would refund a proportionate share of the expenditure.

It was also decided that similar copies of the *kilogramme* or unit of weight should be constructed, and a committee was appointed to institute, during the interval of the sessions of the commission, certain preliminary experimental researches having reference to the physical and mechanical properties of various materials proposed to be employed and to the actual condition of the existing standards.

This committee, consisting of the French section of the commission and several foreign members, among whom I had the honor of being included, commenced its labors in the spring of the present year.

Having occasion to be in Paris during the greater part of the summer on duty connected with the Coast Survey, I was enabled to take an active part in the work of the committee, and to attend the session of the commission without incurring any special expenditure on that account.

Thirty nations were represented at the session of the international commission held in the autumn of this year. Among its members are included some of the most eminent *savans* of Europe, and its labors cannot fail to exercise a most important influence on the metrology of the world.

The principles and all details for the construction and comparison of the new standards have been fully determined on, and the execution of the work has been intrusted to the French section, with the concurrence of a committee of twelve members of the commission, to serve until its next session. Of this committee I have again the honor to be a member.

A printed copy of the report of the proceedings of the commission will be deposited in the State Department as soon as received. Meantime I append to this report an abstract of the conclusions reached, as presented by M. Tresca, one of the secretaries of the commission, to the French Academy of Sciences.

Their subject-matter is for the most part technical, but I beg leave to ask your attention to paragraphs xxxvi and xxxvii, in which the commission recommends the establishment of an international bureau of weights and measures to be maintained at the common expense, and having for its objects the preservation of the new international standards, their periodic comparison with the national metric standards, the construction of new metric standards for other countries that may desire them, the comparison of the new metric standards with other fundamental national standards and such as have been used in geodetic operations, and all other work tending to secure uniformity and precision in weights and measures.

The French Government has been requested to communicate through the diplomatic channels to the other governments represented this recommendation of the commission, and to invite them to a conference on the proposition.

It cannot be doubted that such a measure would serve to maintain invariability and

precision in all kinds of standards, and would promote that approach to general uniformity which is admitted to be desirable by all, even those to whom the practical difficulties in the way of a general adoption of the metric system of weights and measures in our own country appear insuperable.

The subject of metrology is one in which all nations are alike interested, and it appears desirable to have a common point of contact. The proposed establishment would form the nucleus or model for future co-operation in matters of science having international importance. Our share of annual expense of maintaining it would be insignificant, and I am confident that all men of science in the country will approve of the plan by acclamation when it is once formally brought forward.

Very respectfully, your obedient servant,

J. E. HILGARD,

Assistant Superintendent United States Weights and Measures
and Vice-President of the International Standard Commission.

HON. HAMILTON FISH,
Secretary of State.

METHODICAL STATEMENT OF THE RESOLUTIONS PASSED BY THE INTERNATIONAL METRIC COMMISSION DURING THEIR MEETING AT PARIS IN 1872, PREPARED BY H. TRESCA, ONE OF ITS SECRETARIES.

I.—IN REFERENCE TO THE METRE.

1. For constructing the new international metre, the *mètre des archives* in its existing state is to be taken as the point of departure. (Direct decision.)
2. The commission are of opinion that, considering the actual state of the defining ends of the platinum *mètre des archives*, the new *mètre à traits* can be safely derived from it. Nevertheless this opinion of the commission requires to be confirmed by the several processes of comparison which may hereafter be employed in this investigation. (Committee, 1.)
3. The measure of the international metre shall be deduced from its equation with the actual length of the *mètre des archives*, as determined from the results of all the comparisons made with the aid of the processes which the international commission shall be able to employ. (Committee, 1.)
4. Whilst maintaining the decision that the new international metre ought to be a *mètre à traits*, of which all the countries interested will be furnished with identical copies, constructed at the same time with the international prototype, the commission will engage afterwards to construct a certain number of *mètres à bouts* for countries expressing a desire to have them, and the equations of these *mètres à bouts*, in relation to the new prototype *à traits*, will be in like manner determined by the labors of the international commission. (Direct decision.)
5. The international metre shall have the length of a metre at the temperature of 0° C.
6. For the material of the metres an alloy shall be used of 90 per cent. of platinum with 10 per cent. of iridium, and a tolerance of 2 per cent. in excess or deficiency. (Committee, 2.)
7. The measuring bars shall be constructed from one ingot produced at a single casting, by means of the processes usually employed in working known metals. The number and form of the metres shall be determined by the commission. (Committee, 2.)
8. These bars shall be annealed for several days at the highest temperature, in order that they may be submitted to the least mechanical action, before placing them on the comparing apparatus. (Committee, 2.)
9. The bars of platinum-iridium on which the defining lines of the *mètres à traits* are to be cut shall have a total length of 102 centimetres, and their transverse section as proposed by M. Tresca. (Committee, 3.)
10. The bars intended for the *mètres à bouts* shall have an analogous transverse section, but symmetrical in a vertical direction as shown by the figure represented. The ends shall have a spherical surface of one metre radius. (Committee, 3.)
11. During all the operations with these standard metres, they shall be supported on two rollers, as pointed out by Baron Wrede; but for future preservation they shall be placed in proper and convenient cases. (Committee, 3.)
12. Every international metre shall be accompanied by two detached mercurial thermometers, carefully compared with an air-thermometer, and which should be re-verified with it from time to time. (Committee, 4.)
13. The method of M. Fizeau shall be employed for determining the dilatation of the platinum-iridium to be used for constructing the metre. (Committee, 4.)
14. The standard-bars shall be subjected to the best processes by means of which the co-efficient of absolute dilatation of the whole metre may be determined. These

operations shall be applied to each metre separately at five different temperatures at least, between 0° and 40° C. (Committee, 4.)

15. The comparisons between the several standard metres shall be made at not less than three different temperatures between these limits. (Committee, 4.)

16. The commission decides that two comparateurs shall be constructed, one with longitudinal displacement for tracing the lines of the metres, the other with transversal displacement for their comparison. (Committee, 6.)

17. The comparisons are to be made by immersing the new standards in a liquid and in air, but the standard *mètre des archives* is not to be placed in any liquid before the end of the operations. (Committee, 6.)

18. The tracing of the lines on the metres, and their first comparison with the *mètre des archives*, shall be carried out by M. Fizeau's process. (Committee, 6.)

19. For determining the equations of the several standards, all the other methods of comparison already known and approved shall be also employed; that is to say, by using, according to circumstances, either contact pieces of different forms, or the method of MM. Airy and Struve, or that of MM. Starmark and Steinheil. (Committee, 6.)

20. The equations between the *mètre des archives* and the new international *mètre à traits*, as well as the equations between the other *mètres à traits* and the international metre, shall be determined from an examination of the results of all these observations. (Committee, 6.)

21. In the construction of the *mètres à bouts*, which may be demanded by the governments of the several countries, the operations shall be carried on inversely, the new international standard metre being the point of departure. (Committee, 6.)

II.—IN REFERENCE TO THE KILOGRAM.

22. Considering that the simple relation which was established by the originators of the metric system between the unit of weight and the unit of volume is represented by the actual kilogram in a manner sufficiently exact for the ordinary uses of industry and of commerce, and even for most of the ordinary requirements of science; considering also that the exact sciences have not the same need of a simple numerical relation, but only of a determination of such relation as perfect as possible; and considering the difficulties that would arise from a change in the actual unit of the metric system, it is decided that the international kilogram shall be derived from the *kilogramme des archives* in its actual state. (Direct decision.)

23. The international kilogram shall be determined with reference to its weight in vacuum. (Committee, 5.)

24. The material of the international kilogram shall be the same as that of the international metre—that is to say, platinum-iridium containing 10 per cent. of iridium, with a tolerance of 2 per cent. of excess or in deficiency. (Committee, 9.)

25. The metal of the kilogram shall be fused and cast in a single cylinder, which shall then be submitted to furnace heat and to mechanical operations for giving to its whole mass all the requisite homogeneity. (Committee, 9.)

26. The form of the international kilograms shall be the same as that of the *kilogramme des archives*—that is to say, a cylinder with the height equal to the diameter, and the edges slightly rounded. (Committee, 9.)

27. The determination of the weight of a cubic decimeter of water ought to be made by the international commission. (Committee, 3.)

28. The balances to be used for the weighing shall be not only those placed at the disposal of the commission by institutions and individual men of science possessing them, but also a new balance to be constructed so as to give results of the greatest precision. (Committee, 10.)

29. The volumes of all the kilograms shall be determined by hydrostatic weights, but the *kilogramme des archives* shall not be placed either in water or in a vacuum before the end of the operations. (Committee, 10.)

30. For determining the weight of the new international kilograms in relation to the *kilogramme des archives* in a vacuum, two auxiliary kilograms shall be employed as nearly as possible of the same volume and the same weight as the *kilogramme des archives*, according to the method indicated by M. Stas. Each of the new international kilograms shall also be compared in air directly with the *kilogramme des archives*. (Committee, 10.)

31. The new prototype kilogram being selected, all the other international kilograms shall be compared with it, both in air and in vacuum, in order to determine their equations. (Committee, 10.)

32. For these objects both the method of alternation of the weights and that of substitution with counterpoise of a similar material shall be employed. (Committee, 10.)

33. The corrections for loss of weight in air shall be made by taking the data accepted as the most accurate and the most scientifically determined. (Committee, 10.)

III.—IN REFERENCE TO THE ACTUAL OPERATIONS FOR CARRYING OUT THE DECISIONS OF THE COMMISSION.

34. The International Metric Commission are of opinion that in the fulfillment of their mission there should be constructed as many identical standard metres and kilograms as may be demanded by the several countries interested; that all the standards should be compared under the superintendence of the commission, and their equations determined with the utmost precision; that then one of these metres and one of these kilograms should be selected as international prototypes, in terms of which the equations of all the others should be expressed; and finally, that the other standards, so completed, should be distributed indiscriminately among the several countries interested.

35. The construction of the new standards of the metre and kilogram, the tracing of the defining lines, and comparisons of the new metric standards with those of the archives, as well as the construction of the auxiliary apparatus necessary for these operations, are confided to the French section, with the concurrence of the permanent committee, provided for in the following article.

36. The commission shall elect from its body a permanent committee, whose functions shall continue in force until the next general meeting of the commission, with the following organization and attributes:

(a.) The permanent committee shall be composed of 12 members, all belonging to different countries. For valid deliberation, at least five of its members must be present; they shall choose their president and secretary; they shall meet at all times that they may deem necessary, and at least once a year.

(b.) The permanent committee are to direct and superintend the execution of the decisions of the international commission relating to the comparisons among themselves of the new metric standards, as well as the construction of the comparateurs, balances, and all other auxiliary instruments required for these comparisons.

(c.) The permanent committee will execute the operations specified in the preceding paragraph (b) with all the appropriate means at their disposal. For these operations they will have recourse to the international bureau of weights and measures so soon as it shall be founded by the several states interested.

(d.) When the new standard shall be constructed and compared, the permanent committee will submit a report of all their operations to the international commission, whose sanction must be given to the new standards before they are distributed to the several countries.

37. The international commission desires to notify to the several governments interested the great utility of founding an international bureau of weights and measures, upon the following bases:

1. The establishment to be international, and declared neutral.

2. Its seat to be at Paris.

3. It shall be founded and maintained by common contributions from all countries who shall be parties to the treaty to be entered into by the governments interested for the creation of the bureau.

4. The establishment shall be subordinate to the international metric commission, and be placed under the supervision of the permanent committee, who shall appoint the director.

5. The international bureau shall be charged with the following duties:

(a.) It shall be at the disposal of the permanent committee for the comparisons which shall serve as bases of the verification of the new metric standards, with which the committee are charged.

(b.) The custody and preservation of the international prototypes, in accordance with the regulations laid down by the international commission.

(c.) The periodical comparisons of the international prototypes with the several international standards and their attested copies, as well as of the standard thermometers, according to regulations established by the commission.

(d.) The construction and verification of such new metric standards as may be required in future by other countries.

(e.) Comparisons of the new metric prototypes with other fundamental standards established in different countries, and for scientific purposes.

(f.) Comparisons of standards and scales of precision which may be sent for verification, either by the several governments or by scientific societies, and even by individual mechanicians or men of science.

(g.) The bureau shall carry out all the operations required by the commission or its executive committee in the interests of metrology and of the metric system.

38. The bureau of the international commission is directed to address to the French Government a request that they will communicate diplomatically to the governments of all the countries represented at the commission these views of the commission in relation to the establishment of an international bureau of weights and measures; and that they will invite these governments to conclude a treaty for creating as soon as

possible, and with a common accord, an international bureau of weights and measures upon the basis proposed by the commission.

IV.—IN REFERENCE TO THE PRESERVATION OF THE STANDARDS AND THE GUARANTEE OF THEIR INVARIABLENESS.

39. The international commission considers that the international standard metre ought to be accompanied by four identical measures of length, maintained in like manner with it at a temperature as little variable as possible; another identical measure of length ought to be kept, by way of experiment, in an invariable temperature, and in a vacuum. Steps should be taken for establishing other attesting measures of quartz and beryl, that may be compared at all times with the entire standard metre, either in one length or in parts.

Such principal modes of control and of preservation of the standard now recommended should not be the only ones. The commission will be better able to decide upon these points when the standards shall have been completed and sanctioned by their authority, and when it may have been possible to collect together more precise information as to the conditions which it may be desirable and practicable to lay down for the due preservation of the standards in all the countries interested, in order that their full validity may in future be assured.

40. The commission expresses a desire that, in the interests of geodesical science, the French Government will take steps for measuring anew, on a convenient opportunity, one of the old French bases.

After reading this paper before the French Academy of Sciences, M. Tresca added that all the resolutions had been passed by the commission with one accord, and in a spirit of perfect confraternity, all the votes having been nearly unanimous.

No. 4.

UNITED STATES COAST-SURVEY OFFICE,
Washington, D. C., March 6, 1873.

SIR: The proposition for the establishment of an international bureau of weights and measures, submitted by the Government of France upon the recommendation of the International Metric Commission, meets with my entire approval. The objects of the institution, as set forth in the programme, are of great importance to metrology and geodesy, and can best be obtained by the concerted action of all civilized nations. Its usefulness is independent of the question of the general adoption in our country of the metric system, the use of which has already been legalized; since accuracy of comparison and tests of permanence are equally important, whether the standards are identical or of ascertained relations.

I therefore recommend that our government entertain the proposition to join other nations in a diplomatic conference on the basis submitted by the commission, carefully guarding two paramount conditions, viz., that our national standard be kept entirely free from any foreign control, and that the international standard and establishment be at all times freely accessible to us.

As the subject is one of great importance to science, and the proposition has received the attention of the leading scientific bodies of other nations, I would also recommend that it be referred to the National Academy of Science, for a report, through its president, Prof. Joseph Henry.

Very respectfully,

BENJAMIN PEIRCE,

Superintendent United States Weights and Measures.

Hon. GEORGE S. BOUTWELL,
Secretary of the Treasury, Washington, D. C.

No. 5.

TREASURY DEPARTMENT,
Washington, D. C., March 7, 1873.

SIR: I have the honor to refer to you a communication from the French Government, relative to the establishment of an international Bureau of Weights and Measures, and would request that a committee of the National Academy of Sciences make a report to this department on the proposition submitted.

You are respectfully requested to return the inclosed communication.

I am, very respectfully,

GEO. S. BOUTWELL,
Secretary.

Prof. JOSEPH HENRY, LL. D.,
President of the National Academy of Sciences, Washington, D. C.

To JOSEPH HENRY, LL. D.,
President of the National Academy of Sciences:

SIR: The undersigned "Committee of the National Academy of Sciences," appointed by you as president, in compliance with a request of the Secretary of the Treasury of the United States, made in a letter transmitting for examination, and report certain papers relating to a proposition on the part of the Government of France for the establishment of an International Bureau of Weights and Measures, have attended to the subject referred to them, and beg leave to report as follows:

The proposition of the French Government, mentioned above, which is addressed not only to the Government of the United States, but to all other governments with which that of France is in diplomatic communication, has been made in response to a resolution of the International Metric Commission of 1870-'72, adopted at the conclusion of the final session of said commission in the year last mentioned. This international commission, in which were present the accredited representatives of thirty different nations, was originally called for the purpose of considering the condition of the prototype standards of the metric system of weights and measures, now deposited in the Palace of the Archives in Paris, and the expediency of replacing these by other standards exactly copied from them, or corrected for the exceedingly minute differences supposed to have been detected between them and the national dimensions from which they were derived, to serve in either case as new prototype bases of the common system of metrology of the metric nations. Such being its declared object, the deliberations of this assembly might not at first view seem to have possessed any important interest to nations among whom the metric system has not yet been received, and accordingly the participation in its proceedings of delegates from such might appear to be due to no more earnest motive than the spirit of international comity, or a mere feeling of scientific curiosity. It is true, nevertheless, that whatever concerns the exact determination and the permanent preservation of the standard bases of any system of metrology is important to every people who may be in relations of friendly intercourse with that in which such system is in use, since any uncertainties or errors which may exist in regard to them, if gross, will introduce confusion into the affairs of commerce, and, if only slight, will violate the results of scientific observations, and deprive of value the most careful and patient labors of the investigator.

In regard to the metric system these propositions are especially true, since this system has become the only legal system of weights and measures for more than one-half the civilized world. It has been adopted wholly or partially by all the nations of Continental Europe, except the Russian and the Scandinavian; by Mexico, and all South America; and by British India, with her one hundred and fifty millions of inhabitants. In Great Britain, since 1864, its permissive use has been legalized, and the effort to introduce it as the exclusive system in that country—an effort which on one or two occasions already has been nearly successful in Parliament—prosecuted from year to year with constantly increasing activity. The Royal Standard Commission, appointed in 1862, of which the astronomer royal was chairman, reported in the following year, recommending the introduction of the system in the United Kingdom, and their report was accompanied by an elaborate argument from W. W. Chisholm, esq., warden of the standard, in favor of the recommendation.

In the year 1855, there was formed in London, with an extensive membership in the country, an organization designed to advocate the introduction into England of a uniform decimal system of weight and measures, which organization has ever since been earnestly urging the adoption of the metric system; and the British Association for the Advancement of Science has for many years maintained a standing committee called the metric committee, of which the object is the same. The chambers of commerce of the principal towns in England, many farmers' clubs and workingmen's associations, and many scientific societies in the same country have also declared in favor of the same system. And what is perhaps still more significant, since in processes of manufacture involving the use of machinery changes in the measure of length are likely, if anywhere, to be inconvenient, the most eminent mechanical engineers in England are open advocates of the substitution of the meter for the British yard. In the United States, because of our wide separation from the metric nations with whom our business relations are most intimate, our people do not individually feel, at least to any great degree, the embarrassment which arises from having daily to deal with discordant measures of quantity and value; yet our foreign commerce is greatly hampered by delays in the custom-houses, and by the increased labor imposed upon importers and upon the collectors of the revenues, resulting from this cause. When Great Britain shall have adopted the metric system—an event which cannot be very distant—the disadvantage of continuing to be the only important commercial nation maintaining a metrological system out of harmony with the rest will be felt by our people so sensibly as to impel them without doubt to follow her example without much delay. The objects for which the international metric commission was assembled were, therefore, of hardly less interest to the non-metric nations than to those by which the meter has been already received, since this dimension represents to them their own

probable future standard of length. But the enlarged and liberal view taken by the commission of its proper functions, after it had been assembled, was such as to make this interest not merely, as here indicated, prospective, but direct and immediate. The attention of the commission was, in the first instance, naturally occupied with the object of replacing the platinum meter-bar of the archives, which is liable to the objection that it is the natural standard of France, by a new prototype, identical with that in length, to be the common standard of the metric nations, and ultimately the common property of all mankind. This plan having been matured, and provision made for the careful preservation of the prototype, and for the multiplication of authentic copies of the same, to be distributed among the nations, and made the local standard of measure in different parts of the world, the commission proposed greatly to enlarge the usefulness of the permanent organization, to which these tasks should be committed, by charging it with the duty of comparing and verifying all standards of precision, of whatever kind, in measure or weight, which may be sent to it for that purpose, whether by governments or by scientific organizations or by individual investigators or artisans. By this means the relation of the national standards of non-metric nations to the base of the metric system and to each other will be determined with the highest degree of accuracy, and the great works of geodesy, which have been founded on different units of measure, will become strictly comparable. The directors of such great works, the ordnance survey of Great Britain, for example, and our own coast survey, have, from time to time, expended a vast amount of labor in making these determinations—determinations which are greatly exhaustive of time, and of which the results are still, to some degree, discordant, and are not wholly satisfactory. It will be in the power of the international bureau to prosecute these comparisons under circumstances of advantage which have not been hitherto enjoyed, and to follow them out persistently until uncertainty shall no longer be felt to affect the results. The proposition also to verify the scales or standards of measurement presented by investigators or citizens, scales designed to be used in experimental inquiries, will give a new degree of precision to the results of observation, and make it possible to combine the observations of different observers with a degree of confidence which it is not now possible to feel.

It appears, therefore, to the undersigned that the creation of an international bureau for the objects set forth in the proposition of the International Metric Commission cannot but be attended with important advantages, both practical and scientific, to all nations which shall unite in maintaining such an institution. Subject as the proposed bureau will be to the control and direction of a permanent committee of which no two members will be appointed for the same nation, it seems impossible that it can be perverted from its original design to subserve any secondary interest. On the other hand, the concurrence of the nations in a common effort to promote an object pacific in its nature, and peculiarly characteristic of an advanced civilization, an object which, while it concerns directly the material welfare, concerns at the same time, indirectly and to an important degree, the intellectual progress of the human race, cannot but be regarded with gratification for its own sake by every friend of humanity, as evincing some slight recognition of the principles of the solidarity of peoples—a principle which, in the coming centuries, is unquestionably destined to ameliorate the condition of the world.

The undersigned therefore concur in recommending that the Secretary of the Treasury be advised that, in the view of the National Academy of Sciences, the Government of the United States would not act unwisely in entering into a treaty stipulation with the Government of France to lend the aid of this government in the creation and maintenance of the proposed International Bureau of Weights and Measures.

All of which is respectfully submitted.

F. A. P. BARNARD, *Chairman.*
H. A. NEWTON.
M. C. MEIGS.
WOLCOTT GIBBS.
STEPHEN ALEXANDER.
J. PETER LESLEY.
J. E. HILGARD.
JOSEPH HENRY.

No. 6.

Table showing the amounts to be contributed by the different states toward the International Bureau of Weights and Measures.

States.	Population.	Co-efficient.	Product to nearest million. F. 400,000.	Annual expenses.		
				Initial expense, F. 400,000.		1st period, F. 75,000.
				Unit, F. 498.13.	Unit, F. 93.40.	
1 Germany	41,610,150	3	123	F. 61,270	F. 11,488	F. 7,659
2a $\frac{1}{2}$ Austria	20,136,283	3	60	29,888	5,604	3,736
2b $\frac{1}{2}$ Hungary	15,508,575	3	47	23,412	4,390	2,927
3 Belgium	5,253,821	3	16	7,970	1,494	996
4 Argentine Confederation	2,000,000	2	4	1,993	374	249
5 Denmark	2,000,000	1	2	996	187	125
6 Spain	24,236,590	3	73	36,363	6,818	4,546
7 United States of America	38,925,598	2	78	38,854	7,285	4,857
8 France	40,943,120	3	123	61,270	11,488	7,659
9 Italy	26,801,154	3	80	39,850	7,472	4,982
10 Peru	2,500,000	3	8	3,985	747	498
11 Portugal	5,400,000	3	16	7,970	1,494	996
12 Russia	76,500,000	1	77	38,356	7,192	4,795
13a $\frac{1}{2}$ Sweden	4,341,559	1	4	1,993	374	249
13b $\frac{1}{2}$ Norway	1,795,000	2	4	1,993	374	249
14 Switzerland	2,669,147	2	5	2,491	467	311
15 Turkey	39,000,000	2	78	38,854	7,285	4,857
16 Venezuela	1,784,194	3	5	2,491	467	311
Total	350,850,191	...	803	399,999	75,000	50,002

No. 7.

Resolutions passed by American Metrical Society, May 19, 1875, at New York City.

Resolved, That this society has received with gratification the intelligence of the ratification of a convention between the leading powers of the civilized world establishing an international bureau of weights and measures, for the purpose of perpetuating forever without change the basic units of the metric system of weights and measures and the distribution of authenticated copies of the prototype standards of that system, as well as for the exact comparison of standards of all descriptions and the determination of their relations to those of the metric system.

Resolved, That the action of our own executive government in accrediting a representative of the United States to the diplomatic conference in which this convention was entered into, and in authorizing its representative to sign the convention on the part of the United States, is especially gratifying as evincing the sympathy of the enlightened statesmen at the head of our government with all measures which tend, like the simplification of metrological systems, to facilitate international intercourse, and to thus promote peace and harmony between different peoples.

C. G. ROCKWOOD, JR.,
Recording Secretary A. M. S.

No. 8.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—REPORT OF THE COMMITTEE ON WEIGHTS, MEASURES, AND COINAGE.—DETROIT MEETING, 1875.

[From the proceedings of the association.]

REPORT OF THE COMMITTEE ON WEIGHTS, MEASURES, AND COINAGE.

The object for which the committee on weights, measures, and coinage of the Association for the Advancement of Science was originally appointed was not that it should consider matters at that time definitely laid before it, and after reporting be discharged,

but that, like the analogous committee of the British Association, it should take cognizance of all the movements which may be going on throughout the world in regard to matters relating to this subject, and should advise the association, from time to time, as to the modes in which it might promote the general progress of improvement by the expression of its sympathies, or by invoking the action of other bodies whose co-operation might be likely to subserve the same cause.

The purpose of this report is, therefore, to call the attention of the association at this time to the results of the recent international diplomatic conference, of which the sessions were concluded in the month of March last, and to the international convention adopted by that congress, and signed by the diplomatic representatives of twenty-one nations, among whom the representative of the United States is included.

This conference was invited early in the year 1870, at the instance of the European Geodesic Association, by the Government of France. The invitation was extended to all the nations with which France is in friendly diplomatic intercourse, and its object, as stated, was to ask the co-operation of such nations in an endeavor, through an international commission, to provide adequate securities for the perpetuation, unaltered forever, of the basic units of the metric system; for the discussion and final settlement of any question which had been or might be raised as to the literal conformity of the prototype standards with the natural dimensions which they purport to represent; and for the provision of authentic copies of those prototypes to be deposited with the several metric nations, and all others which should desire them, as local standards of comparison, and verification. The invitation was generally accepted, and delegates appointed by the different nations were assembled for the first time in the summer of 1870, in Paris. The delegates appointed on behalf of the United States were Prof. Joseph Henry, secretary of the Smithsonian Institution, and Prof. J. E. Hilgard, of the Coast Survey, now president of this association. At this earliest meeting, at which Professor Henry appeared for the United States, certain general principles were agreed upon for the guidance of future proceedings; but in consequence of the war, which raged with such violence between France and Germany during that year, no active measures were attempted.

A second meeting took place in 1872, at which there were represented, by their delegates, thirty different nations, Professor Hilgard appearing on behalf of the United States. On this occasion, after mature deliberation and discussion, it was resolved that the original standard meter and kilogram should be adhered to as standards of length and weight. The original standard meter had been what is called an end-meter, or a *mètre à bout*. But as, in comparisons with such a meter, the extremities are liable to be injured by repeated contacts, however delicate, the commission resolved that the new meters should be line-meters, or *mètres à trait*—that is, measures in which the standard is the distance between two delicately-traced lines on the surface of the metal, these lines to be observed microscopically, and never touched.

For material they adopted an alloy of platinum and iridium, ten per cent. of the metal last named being united with ninety per cent. of pure platinum. Of this material, also, they resolved to make the kilogram. The expansibility of this material is slight, while its hardness and rigidity are great, and it resists all acids and all ordinary artificial heat. It is only fusible in a furnace specially constructed for the purpose, in which the material, supported on a bed of lime, is exposed to the direct action of many jets of the oxyhydrogen blow-pipe. In order to secure the highest degree of rigidity in the mass of metal forming the standard meter, it was determined to give to the bar a cross-section resembling in part the letter X and in part the capital H, the lines denoting the limits of the standard to be traced on the bottom of the trough thus formed on one side of the cross-bar of the H.

Inasmuch, also, as it was designed to furnish all the metric nations with carefully compared and verified standards accompanied by their certified equations, and as it was desirable that these standards should be as nearly as possible identical in character in every respect, it was further resolved to construct the whole from a single ingot, formed at one operation of melting.

The difficult and responsible duty of accurately preparing the bars in accordance with these rules was intrusted to the delegates constituting the French section of the commission. An executive committee chosen from the delegates of the different nations, to the number of twelve, in which committee our country is represented by Professor Hilgard, was charged with the subsequent duty of receiving, comparing, and verifying these standards. These verifications having been accomplished, the committee were required to call the entire commission together and to deliver over to that body the standards thus finally completed.

It being evident that, in order to secure permanently to the nations represented and to the world the benefits contemplated in the institution of this commission, some permanent organization would be necessary to take charge of the standards created, to attend to their distribution, to prepare new ones, if such should hereafter be necessary, to recompare hereafter those originally distributed, if such verification should be desired, and further, to compare and verify standards of measure of any kind,

whether metric or not, for nations or for municipalities, or for corporate bodies, or even for individuals, it was finally resolved that the French Government should be requested to invite a diplomatic conference of the nations for the purpose of advising as to the proper plan of such an organization, and as to the means of maintaining it.

In consequence of this suggestion, such an invitation was issued in January, 1873. On the receipt of the invitation from the French Government by that of the United States, the president of the National Academy of Sciences was invited by the Secretary of State to lay before him such information in regard to the nature of the proposed scheme, its relations to the interests of science, and its more direct importance to the material welfare of mankind, as might enable him to advise the President of the United States as to the expediency of acceding to the invitation. The president of the academy referred the subject to a committee, by whom a formal report was drawn up, which was presented to the president of the academy, and by him transmitted to the Secretary.

The impression produced by this upon the mind of the President of the United States was so favorable that, without hesitation, he appointed Mr. Washburne, our minister at Paris, to represent our country in the proposed diplomatic conference. The call for the conference was issued in December, 1874, and the conference itself was actually convened in March, 1875. A convention was entered into by the delegates, on behalf of the nations represented by them, in which it was stipulated that provision should be made by appropriations, *pro rata*, from the different assenting nations, for the maintenance of the international bureau. A scheme of organization for this bureau was approved, and a budget in which estimates were embraced in regard to the original cost of construction and preliminary operations, and in regard to the future annual support of the bureau, was also approved.

This committee see no occasion for going more particularly into details in regard to the plan of the proposed permanent bureau, inasmuch as the president of the association, who is a member of the executive committee of the international commission, will probably make a communication, written or oral, to the association on the subject. The point which the committee desire to press upon the association is this: The delegates to the diplomatic conference who have affixed their signatures to the convention have done so, in a few instances, subject to the approval of their governments. Others have acted with the full authority of their governments. It is gratifying to know that the President of the United States, on having been consulted by Mr. Washburne upon the question of affixing his signature, was authorized by telegraph to do so, and signed the convention accordingly.

The United States are, therefore, one of the signatory powers; and, so far as the action of the executive government can go, we are a member of an international league more honorable to civilization than almost any other that was ever entered into by such high contracting parties.

As, however, in order that our engagements may be fulfilled, it is necessary that our Congress should make provision to defray the portion of the accruing expense which falls to our share, it seems desirable that an expression should be laid before Congress by the scientific men of the country, signifying their estimate of the importance of this measure, and praying them to make the slight appropriations required. These will amount to not more than \$10,000 in the first instance, and the future annual smaller sum of \$900.

It is to be considered that this organization is not designed merely to advance the interests of the metric system of weights and measures, or to serve as a means of promoting the extension of that system. Its design is higher than that. To secure the universal adoption of the metric system would be undoubtedly to confer an immense and incalculable benefit upon the human race; but it would be a benefit felt mainly in the increased facilities which it would afford to commerce and to exactness in matters that concern the practical life of humanity. But to secure that severe accuracy in standards of measurement which transcends all the wants of ordinary business affairs, yet which, in the present advanced state of science, is the absolutely indispensable condition of higher progress, is an object of interest to the investigators of nature immensely superior to anything which contemplates only the increase of the wealth of nations.

This international bureau proposes now to provide for science precisely that which science in the present age of the world demands—such minute exactness of measurement that observations of the most delicate character which may be made in Germany, or Italy, or France, or England, may be exactly and quantitatively known to the investigator in the United States, who reads the measures as they are set down in the journals and the memoirs in which the original observations are described. It is of secondary consequence whether the standards are metric standards or standards such as are in use among ourselves. This bureau will equally verify them all, and compare them all with standards of other nations founded on different linear bases, so long as such differences shall continue to exist. It is, therefore, not merely an international bureau of weights and measures, but it may, with equal propriety, be called an inter-

national bureau for the promotion of exactness in scientific determinations. And it will be as much the organ of institutions like this association, like the National Academy, like the Royal Society, like the French Institute, &c., as it will be that of the governments establishing it. The committee, therefore, recommend that a memorial should be drawn up and signed by all the members of the association, whether here present or now at their homes, urging Congress, in behalf of American science, to make the trivial appropriation required to enable our country to be a participant in the maintenance of an organization so honorable to our age and so important to the interests we have at heart.

F. A. P. BARNARD,
Chairman.

J. E. HILGARD,
H. A. NEWTON,
J. LAWRENCE SMITH,
JOSEPH HENRY,
W. B. ROGERS,
BENJAMIN PEIRCE,
E. B. ELLIOTT,
Committee.

DETROIT, August 17, 1875.

After the acceptance of the report, the following resolutions, recommended by the standing committee, were unanimously adopted:

Whereas, in the investigations of science, precision in the determination of quantities is essential to the discovery of truth, and therefore every measure which has for its object to secure or maintain accuracy in the standards of measurement is directly promotive of scientific advancement, and is of interest to any investigator;

And whereas it has been made known to this association that a convention was entered into early in the present year by the leading powers of the civilized world, through their diplomatic representatives, providing for the creation and maintenance, in the city of Paris, of an organization to be called "The International Bureau of Weights and Measures," for the preparation, verification, and distribution to the governments of all the assenting powers of accurate standards of measurement, and for the preservation unaltered forever of the prototypes from which such standards are derived; to which convention the Government of the United States became a party by the assent of the President and the signature of its authorized representative;

And whereas, for the purpose of defraying the cost of the necessary buildings and equipment and for the maintenance of such bureau in the discharge of its proposed functions, it is provided in the said convention that each of the high contracting powers shall contribute according to a scale dependent on its population and its relation to the metric system, the amount of such contribution being in every case inconsiderable and entirely insignificant in comparison with the advantages to be derived: Therefore,

Resolved. That a memorial address to the Congress of the United States on behalf of this association be prepared for signature at this present meeting, praying the Senate to confirm the action of the executive department, and praying Congress to make early provision to discharge the obligations resting upon us, in consequence of the provision of the international convention above mentioned, distributing the burden of expense attendant on the creation of the International Bureau of Weights and Measures, and on its subsequent maintenance, among the signatory powers, and that the said memorial be signed not only by the members of this association here present, but also by such of those not in attendance as may choose to attach their signatures, to the end that the prayer of the memorial may be made, if possible, unanimous.

Resolved further. That such memorial, when so signed, be transmitted in duplicate to the presiding officers of the Senate and House of Representatives by the president of the association, immediately on the assembling of the Forty-fourth Congress, in December next.

In pursuance of this action, the following memorial was drafted and numerously signed before the adjournment of the association:

To the Senate and House of Representatives of the United States in Congress assembled:

The undersigned, members of the American Association for the Advancement of Science, having learned with great satisfaction that a convention has been entered into by the leading nations of the world for the establishment and maintenance of an international bureau of weights and measures, with the object of promoting permanence, precision, and uniformity in the standards, at the joint charge of the contracting powers, and that the Government of the United States has agreed to the same through its diplomatic representative, subject to the ratification of the Senate, do now, for the considerations set forth in the accompanying report and resolutions, respectfully urge that the Senate, without delay, ratify said convention, and that Congress make the requisite appropriation to carry the same into effect.

No. 9

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE.
February 17, 1876.

SIR: Referring to previous correspondence in reference to the metrical convention some time since concluded in Paris, I have the honor to inform you that I have caused a translation, which was submitted to you for approval, to be carefully examined since its return from your department, and have adopted almost entirely all the modifications suggested in the communication addressed to you from the Bureau of Weights and Measures.

Some few changes have been made with a view of presenting the formal parts of the convention in more perfect translation. I now submit to you a copy of a translation of the entire convention, which, if requested by you, I will cause to be submitted, with the original, by the President for the action of the Senate.

As the matter in question pertains properly to your department, it is supposed that any information or communication which may properly be made in furtherance of the ratification of the convention, or in reference to legislation respecting the same, will be made from your department. I will thank you to return the translation at an early day with an expression of your views concerning the subject.

I have, &c.,

HAMILTON FISH.

No. 10.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT, March 6, 1876.

SIR: I have the honor to transmit herewith, in reply to your communication of the 17th ultimo, relating to the convention for an international bureau of weights and measures, a copy of a letter of the 3d instant from C. P. Patterson, Superintendent of the United States Coast Survey, in which he forwards the accompanying report, with the statement that it recites briefly the circumstances which led to the convention, its objects and purposes, and the legislation required to carry it into effect. This report, he states, has been prepared by Mr. J. E. Hilgard, assistant in charge of weights and measures in the Office of the Coast Survey, who, as a delegate from this country to the international metric commission, is conversant with the whole history of the convention, and he requests that it be transmitted to you with the accompanying documents, for presentation to the Senate at the time the convention is submitted for ratification. He further states that in the event of such ratification an appropriation will be requisite, an item for which has been duly presented, and appears on page 152 of the printed volume of Estimates.

The translation of the metrical convention, forwarded to this department with your letter of the 17th ultimo, is also herewith returned, the corresponding copy in the Office of the Coast Survey having been made conformable to it.

I have, &c.,

B. H. BRISTOW,
Secretary.

Mr. Patterson to Mr. Bristow.

UNITED STATES COAST-SURVEY OFFICE,
Washington, March 3, 1876.

SIR: I have the honor to transmit, in reply to the department letter of February 21, which inclosed a communication of date February 17, addressed to the department by the honorable Secretary of State on the subject of the convention for an international bureau of weights and measures, the accompanying report, reciting in brief the circumstances which led to the convention; also its objects and provisions, and the legislative action requisite to carry it into effect. This report has been prepared by Mr. J. E. Hilgard, assistant in the Coast Survey, in charge of the office, and who, as a delegate from this country to the international metric commission, is conversant with the whole history of the convention.

The objects of that convention appear to me as of great value to the interests of science, and, so far as I can learn, they are deemed very desirable by those who are best qualified to form an opinion in regard to the importance of the objects sought.

I would respectfully suggest that the report of Mr. Hilgard, with its accompanying documents, be transmitted to the honorable Secretary of State with the view of their presentation to the Senate at the same time when the convention is submitted for rat-

ification. In the event of such ratification, an appropriation will be requisite, and for that purpose an item was included in estimate which I presented to the department in October last, and which appears on page 152 of the printed volume of Estimates.

The translation sent by the honorable Secretary of State, through the Treasury Department, is herewith returned, the corresponding copy in this office having been made conformable to it.

I am, &c.,

C. P. PATTERSON,

Superintendent United States Coast Survey, and Weights and Measures.

REPORT OF THE PROCEEDINGS OF THE INTERNATIONAL STANDARD COMMISSION, AND ON THE CONVENTION SIGNED AT PARIS MAY 20, 1875, FOR THE ESTABLISHMENT OF AN INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES, BY J. E. HILGARD, ASSISTANT UNITED STATES COAST SURVEY, MEMBER OF THE COMMITTEE.

List of papers appended.

1. Report to Secretary of State, by J. E. Hilgard, December 13, 1872, transmitting project of work of international standards committee.
2. Report of Prof. Benjamin Peirce, Superintendent of the United States Coast Survey, on proposed international bureau of weights and measures.
3. Report of National Academy of Sciences, transmitted by its president, Prof. Joseph Henry.
4. Translation of convention of May 20, 1875, for the establishment of an international bureau of weights and measures.
5. Table of allotment of expenditures.
6. Resolutions of American Metrological Society
7. Report and resolutions of American Association for the Advancement of Science.

REPORT ON THE PROPOSED INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES AT PARIS.

In the spring of 1869 the French Government addressed a circular-note to all governments with whom it had diplomatic relations, inviting them to send delegates to a scientific commission having for its object a revision of the standard unit of the metric system, and the construction of a number of identical standards, to be distributed among the participating states, one of which, selected as an international standard of reference, should be preserved under conditions insuring its invariability. As this proposition obviously tended to promote accuracy and permanence in all kinds of standards, whether metrical or of ascertained relations to the same, it was favorably considered by the Government of the United States, especially since Congress had, in 1866 (act of July 23, 1866), made the use of metric standards optional in the United States, and had directed the Treasury Department to furnish copies of such standards to each State, and the President accordingly designated Prof. Joseph Henry and Mr. J. E. Hilgard as delegates from the United States to the proposed international commission.

The first session of the commission was held at Paris in August, 1870, Professor Henry representing the United States on that occasion. In consequence of the state of war between France and Germany that session was of brief duration. The objects of the commission were discussed, but no conclusion was reached before adjournment.

The second session of the commission was held between the 23d of September and the 8th of November, 1872, at which the United States were represented by Mr. J. E. Hilgard. At this session, at which thirty states, comprising all the civilized nations of the earth, were represented, the subject of the new standards was fully discussed, and the mode of their execution and verification was determined on according to a project set forth in Appendix No. 1. That project provides for the construction of an international meter and kilogram possessing all the qualities of accuracy and permanence which the present state of science can afford, and of exact copies of the same for each of the participating States. These new standards are to conform as nearly as possible to those heretofore legalized in France and adopted by other nations, the originals of which are preserved in the archives of France.

The demand for the reproduction of those originals in a new form arises from the fact that they are of a material so soft and of such form as to be liable to suffer change from frequent use in comparisons. In fact the meter, the fundamental unit, being a

slender bar of soft platinum, defined by its terminal surfaces, already shows visible signs of abrasion by the contacts to which it has been subjected. It is proposed to replace it by a rigid girder-shaped bar of a hard and indestructible alloy of platinum and iridium, near the ends of which the fundamental length of a meter is defined by extremely fine lines, which are only referred to by optical comparison. The new kilogram is to be made of the same hard alloy.

The French members of the commission are to undertake the construction of the new standards, under the supervision of an executive committee of twelve members of the commission, one of whom was the American delegate. The question of the subsequent preservation of the international prototypes, and of the means of future reference to the same for the verification of the national standards from time to time, likewise occupied the attention of the commission, and resulted in the expression of an opinion that it would be expedient to found at Paris an international bureau of weights and measures, to be maintained at the common expense, and having for its objects the preservation of the new international standards, their periodic comparison with the national metric standards, the construction of new metric standards for other countries that may desire them, the comparison of the new metric standards with other fundamental national standards, and such as have been used in geodetic operations, and all other work tending to secure uniformity and precision in weights and measures.

In compliance with the request of the commission, the Government of France communicated its recommendation to the other governments represented, and invited them to a diplomatic conference on the proposition submitted.

The Government of the United States, upon the suggestion of Professor Benjamin Peirce, then Superintendent of the Coast Survey, and as such charged with the construction of metric standards for the States, to whom the matter had been referred for report (see Appendix No. 2), submitted the question to the National Academy of Sciences, which body, through their committee on weights, measures, and coinage, made a report strongly recommending the participation of this country in the proposed international institution. A copy of their report is appended (Appendix No. 3).

The President, adopting their views, thereupon informed the Government of France of the assent of this government to the proposed conference, and designated the American minister at Paris as a delegate to the same.

Pending these negotiations, the work of preparing the new standards was prosecuted by the French members of the scientific commission, under the general direction of an international committee of twelve members, one of whom was the American delegate, Mr. J. E. Hilgard. The latter has also immediate charge of the construction of the metric standards for the States, at the Coast Survey Office in Washington, to which bureau, in conformity with the custom, their preparation had been intrusted by the Treasury Department.

At the session of the international committee, held in Paris in October, 1874, the work upon the new standards was so far advanced as to render it necessary to decide whether the means and appliances requisite for their final verification and intercomparison should be provided, with a view to permanence and future use, or whether the work should be treated as a temporary operation. A large number of the governments represented in the scientific commission having signified their assent to the proposed conference for the establishment of a permanent institution, the French Government, therefore, at the request of the committee, called the conference, which resulted in a convention, a copy of which is annexed. (Appendix No. 4.)

It provides for the establishment and maintenance, at the joint charge of the contracting parties, of a permanent international bureau of weights and measures (*bureau international de poids et mesures*) to be situated at or near Paris, and to be declared neutral. It is to be established in a special building, furnished with the requisite instruments and apparatus, and its operations are to be under the exclusive direction and superintendence of an international committee, composed of fourteen members, all belonging to different countries. Its personal staff is to consist of a director, one or two assistants, and the requisite workmen.

In addition to the primary work of verifying the new international metric standards, the bureau is charged with the following permanent duties:

1. The custody and preservation of the new international metric prototypes and their auxiliary instruments.
2. The future periodical comparisons of the several national standards with the international prototypes and with their test copies, as well as comparisons of the standard thermometers.
3. The comparison with the new primary metric standards of the fundamental standards of weights and measures, other than metric, in the different countries, and in scientific use.
4. The standardizing and comparison of geodetical instruments.
5. The comparison of standards and scales of precision, the verification of which

may be desired either by the respective governments or by scientific societies, or even by constructors and by men of science.

The expenses of the bureau are to be defrayed by contributions from the several governments of the contracting countries, based on the numbers of the population in each country, multiplied by the factor 3 for those countries where the use of the metric system is obligatory, by 2 where it is legalized but not obligatory, and by 1 where that system is not yet legalized.

The cost of acquiring or constructing a special building, and of purchasing and fitting up instruments and apparatus, is not to exceed 400,000 francs (\$80,000). The annual expenditure of the bureau during the work of comparing the new international standards is not to exceed 100,000 francs (\$20,000), and afterward the annual expenditure is limited to 50,000 francs (\$10,000).

The committee is to be itself placed under the authority of a general conference of weights and measures, formed of delegates of all the governments contracting.

The conference-general is to meet at Paris, when convoked by the international committee, at least once in every six years.

Out of the twenty principal countries represented at the conference, the convention of May 20 was signed by the representatives of the following seventeen countries:

Germany,	Italy,
Austria and Hungary,	Pern,
Belgium,	Portugal,
Brazil,	Russia,
Argentine Republic,	Sweden and Norway,
Denmark,	Switzerland,
Spain,	Turkey,
United States,	Venezuela.

France,

The governments of Great Britain and of Holland declined to take part in the convention or to contribute toward the expenses of the new international metric bureau. No announcement has yet been made on the part of Greece.

Provision is made in the convention for the future participation of other states and for the withdrawal of any of the contracting parties after a term of twelve years.

Ratifications were exchanged on the 20th of December, 1875, by twelve states, and at the same time the period of ratification was extended to those states in which there had not been time to obtain the ratification of the legislatures by reason of their not being in session.

Under the terms of the convention, the new international committee was to be composed, in the first instance, of the members of the standing committee of the international commission of 1872, and with a view to avoid needless delay it was authorized to constitute itself at once, and proceed with the preparation of plans for the institution, and take such other measures as would not involve any expenditure. It was accordingly organized by the selection of General Ibanez, of Spain, as president, Dr. A. Hirsh, of Switzerland, as secretary, and Prof. G. Govi, of Italy, as provisional director.

The Pavilion Breteuil, at the entrance of the park of St. Cloud, has been selected by the committee as the site of the international bureau, and the Government of France has offered to transfer the same without charge. The building is in a somewhat ruinous condition, but its walls are excellent, and estimates based upon detailed plans have shown that the building expenses will not exceed 100,000 francs, leaving 300,000 francs of the estimated total cost for instruments, apparatus, and general outfit.

It will be seen from the subjoined table of allotments (Appendix No. 5) that the estimated charge to the United States will be as follows:

1. For the cost of the establishment, 32,554 francs, or \$7,400.
2. Annual contribution for the first period: that of the construction and verification of the new standards, 7,225 francs, or \$1,334.
3. Annual contribution after completion of new standards, 4,857 francs, or \$924.

In the event of the convention being ratified by the Senate, it will be necessary for Congress to make an appropriation sufficient to cover our share of the cost of the establishment and our annual contribution for one year, and estimates to that effect are included in the estimates for the fiscal year 1876-'77, submitted to Congress by the Treasury Department.

The subsequent annual contributions might hereafter be included in the estimates of the Department of State for the fulfillment of treaty obligations. No public expenditure, on account of the proposition in question, has hitherto been made, other than authorized by appropriations for the construction of metric standards for the States. The attendance of Professor Henry, in 1870, and that of Mr. Hilgard, in 1872, at the meetings of the international commission were not attended with any expense charged to public account. The only expenditures yet made are those of transportation of Mr. Hilgard, in 1874, as member of the committee, amounting to \$497, and those of Mr. H. Vignaud, who assisted the American minister, Mr. E. B. Washburne, as expert at the

conference of 1875, amounting to \$425, both of which items were considered by the Treasury Department necessary and proper toward procuring the metric standards for the States, for which purpose appropriations had been made.

In concluding this report it is proper to state that the proposition which forms the object of the convention has received the earnest approbation of a large number of citizens of this country, and the classes engaged in scientific pursuits and in education may be said to be unanimous in its support. In addition to the recommendation of the National Academy of Sciences, resolutions adopted by the American Metrological Society at its meeting in New York, May, 1875, and a report to the American Association for the Advancement of Science, with the resolutions adopted at its meeting in Detroit, August, 1875, are herewith communicated (Appendices Nos. 6 and 7) as evidences of the favorable sentiment entertained throughout the country in regard to the proposed measure.

All of which is respectfully submitted by

J. E. HILGARD,
Assistant United States Coast Survey and
Inspector United States Standard Weights and Measures.

UNITED STATES COAST-SURVEY OFFICE,
March 3, 1896.

CHAPTER III.

RESPONSES OF EXECUTIVE DEPARTMENTS TO THE RESOLUTION OF THE COMMITTEE.

A.

[FORTY-FIFTH CONGRESS, FIRST SESSION.]

CONGRESS OF THE UNITED STATES,
In the House of Representatives, November 6, 1877.

On motion of Mr. Clark, of Missouri,

Resolved, That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress, and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States.

Attest:

GEO. M. ADAMS, Clerk.

Message from the President of the United States, in answer to a resolution of the House of Representatives, concerning the obligatory use of the metrical system of weights and measures.

NOVEMBER 20, 1877.—Referred to the Committee on Coinage, Weights, and Measures, and ordered to be printed.

To the House of Representatives:

In answer to the resolution of the House of Representatives, of the 6th instant, requesting the opinions of the heads of the executive departments respecting the obligatory use of the metrical system of weights and measures, I transmit herewith a report from the Secretary of State.

WASHINGTON, November 20, 1877.

R. B. HAYES.

DEPARTMENT OF STATE,
Washington, November 17, 1877.

The Secretary of State, in response to the resolution of the House of Representatives of the 6th instant—

“That the heads of the executive departments be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress; and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States—”

has the honor to report:

1st. That the obligatory use of the metrical system, so far as the operations of the Department of State are concerned, and especially its consular and commercial rela-

tions with foreign governments, while of convenience and utility with respect to those countries which have already adopted the metrical system to the exclusion of all others, would be of no benefit with regard to those countries which have not so adopted it, and would introduce detrimental confusion, in particular in its commercial relations with Great Britain, and other countries where the system of weights and measures is the same as that of the United States, and with which countries the bulk of our foreign commerce is at present carried on.

2d. That should the obligatory use of the metrical system in governmental transactions be enacted, two years' preliminary notice of the change would suffice to bring the system into harmonious and uniform use in this department and its dependencies abroad.

3d. That the Department of State does not seem to the Secretary of State to be in a position to express an authoritative opinion as to the obligatory adoption of the metrical system in all transactions between individuals, inasmuch as its relations directly with the people of the United States are not of a character to be either beneficially or injuriously affected by the suggested change. He ventures to remark, however, that even in those countries, like France, where the system has been obligatory beyond the memory of the present generation, the tradition of the old system clings among the people and defies complete eradication; and that in other countries, like Spain, where the metrical system is adopted in governmental transactions and legalized for those of individuals, the innovation is practically disregarded by the people, and but partially conformed to by the government, which is compelled to recognize the validity of the old standards, in which the continuing transactions of the nation, such as the registration of landed property, the assessment of industrial taxation, &c., are still, and must be of necessity for many years, recorded. While recognizing that the proposed measure is one mainly affecting the people, and therefore properly to be legislated upon by the popular representatives, the Department of State, being called upon for a specific opinion on the subject, is, on the whole, indisposed to recommend the obligatory use of the metrical system in all transactions between individuals.

4th. That should its obligatory use as between individuals be enacted, a period of not less than five years should be allowed to elapse before the act takes effect; and that, even then, provision should be made for the recognition of the legal validity of transactions according to the present lawful systems of weights and measures.

Respectfully submitted.

WM. M. EVARTS.

To the PRESIDENT.

LETTER FROM THE SECRETARY OF THE NAVY, IN REPLY TO A RESOLUTION FROM THE HOUSE OF REPRESENTATIVES IN REFERENCE TO THE METRICAL SYSTEM OF WEIGHTS AND MEASURES.

NOVEMBER 20, 1877.—Referred to the Committee on Coinage, Weights, and Measures.

NOVEMBER 22, 1877.—Ordered to be printed.

NAVY DEPARTMENT,
Washington, November 19, 1877.

SIR: I have the honor to acknowledge the receipt of the following resolution, adopted by the House of Representatives on the 6th instant:

"That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress; and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States."

If it were desired to make the metrical system of weights and measures obligatory in all government transactions, the Navy Department perceives no objection to it, except in so far as it regards the soundings given on charts. If it were applied to these it would probably involve a total loss of all charts and chart-plates now in use. The alteration of these would give them no increased value; and as long as English charts remain in fathoms and feet it would be, in fact, prejudicial, and prevent that free use and interchange of charts which seems essential to navigators.

So far as this department is concerned, no longer notice would be necessary than was sufficient to furnish the standard weights and measures adopted for government use.

Respecting the last inquiry submitted by the resolution, "What objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States?" the department is unable to give a definite answer, inasmuch as it is not informed as to the present intention of the English-speaking peoples in regard to the adoption of the proposed change. However desirable or advantageous in theory the change might seem, if adopted by us and not by the other peoples speaking the English language, it would seem probable that a mutual disadvantage would exist growing out of diverse weights and measures.

It may be assumed that a more general intercourse will exist between peoples speaking a common language than between peoples who speak different languages. And looking at the present geographical extent of the countries wherein the English language is used, and the importance of their commercial intercourse, and also its future importance, as compared with any other of the spoken languages, at a period not at all remote, if regarded historically, it would seem to be of doubtful expediency to separate ourselves from what is now common in weights and measures with other people who speak our language, and with whom it is desirable to increase rather than diminish our commercial intercourse. Experience would indicate that we should hold ourselves in accord with them, rather than adopt other standards, however theoretically advantageous, for it will be impossible to escape many practical disadvantages if our standards vary from theirs, so long as our intercourse shall continue.

I have the honor to be, very respectfully,

R. W. THOMPSON,
Secretary of the Navy.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

LETTER FROM THE POSTMASTER-GENERAL, IN REPLY TO A RESOLUTION OF THE HOUSE OF REPRESENTATIVES IN REFERENCE TO THE METRICAL SYSTEM OF WEIGHTS AND MEASURES.

NOVEMBER 20, 1877.—Referred to the Committee on Coinage, Weights, and Measures.

NOVEMBER 22, 1877.—Ordered to be printed.

POST-OFFICE DEPARTMENT,
Washington, D. C., November 19, 1877.

SIR: In reply to the request contained in the resolution of the House of Representatives of date the 6th instant (a copy of which is hereto appended, marked A), I have to say that the only objections to making the use of the metric system of weights and measures obligatory throughout the domestic postal service, which occur to me as having been made or as likely to be made, are two: one based on the expense incident to the change of systems, and the other based on an apprehension that the practical workings of a new system will fail to give satisfaction, owing to the lack of knowledge of the metric system and experience in its use and application on the part of a great many postmasters, especially at the small post-offices, and of the public at large.

In order to ascertain the probable force of the first objection, I have caused the blank agent of this department (who is the officer charged with the duty of supervising the supplying of balances and scales for use in the postal service) to make an estimate of the probable number, grade, and cost of the balances and scales of the metric system which should be provided to take the place of those now in use in case a change is ordered. His estimate (herewith submitted, marked B) puts the number of the various grades at 43,867, and Fairbanks & Co.'s (the present contractors) price-list cost of that number of those now in use at \$166,384. Assuming that the cost of metric scales and balances would be no greater than that of the ones now used, and that a discount of 25 per cent. on the list-price would be made, the sum of \$124,788 would be called for as an immediate outlay to provide for the change.

In regard to the second objection, it is not to be denied that the metric system of weights and measures corresponds in principle with the decimal system long in use in the United States for coinage and money-valuations, and that presumptively no greater inherent difficulty is likely to be encountered in the application of the decimal system to our weights and measures in the domestic postal service than was met in the change from the English system of coinage and money-valuations to the present one. The latter is certainly the simpler one, and has for some time past been in use for the foreign mail service of this department. The objection, then, is in my opinion founded on an apprehension that mistakes and consequently resulting annoyances, and possibly losses, would occur in the practical application, and not on any well-grounded objec-

METRIC SYSTEM.

tion to the principle of the metric system. This apprehension would, I believe, be greatly lessened, if not altogether abated, were sufficient time given for familiarizing postmasters and the general public with the practical workings of the new system before discontinuing the use of the old one.

Therefore, if Congress in its wisdom decide that the use of the metric system of weights and measures shall be extended to the entire postal service of this country, I suggest that an adequate appropriation be made to supply all the post-offices in the United States with suitable scales and balances of that system, and that after such supply is completed, a certain time, say six months, be allowed before requiring their obligatory use. Twelve months would, I suppose, be ample time to supply the offices, and eighteen months after such appropriation is available the new system could go into operation.

I have only the same means that any other citizen has of forming a judgment in regard to the last inquiry made in the resolution of the House, and I therefore deem it proper not to attempt to make an answer to it in this connection.

I have the honor to be, very respectfully, your obedient servant,
D. M. KEY,
Postmaster-General.

HON. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

B.

BLANK AGENCY,
Washington, D. C., November 15, 1877.

SIR: In answer to your questions, I can only approximate as to the probable number and cost of the introduction into all the post-offices of the United States of balances denominated in grams of the metric system.

The present number of post-offices in the United States is 37,575, with an average annual increase of one thousand.

Added to this, there are many of the larger offices requiring more than one of the smaller balances, and at all offices where newspapers are mailed in bulk the larger scales are used.

I have therefore thought it fair to estimate as follows:

Weight.	Number.	Price.	Total cost.
8 ounces.....	39,000	\$3 00	\$117,000
4 pounds.....	3,000	8 00	24,000
62 pounds.....	1,200	12 00	14,400
240 pounds.....	600	14 00	8,400
600 pounds.....	50	30 00	1,500
1,000 pounds.....	10	51 00	510
2,000 pounds.....	7	82 00	574
	43,267	166,384	

In computing the prices in the above table, I have taken the "Price-list of Fairbanks & Co." for the ordinary scales now in use, and am informed that a very liberal deduction will be made to cash purchasers.

In regard to the suggestion of attaching a beam to the present letter-balances upon which to weigh by French grams, and the other plan of adapting the scales already in use to this system by sending a "clamping-screw" of the requisite additional weight, to increase, by adding to the poise, each by its nineteenth part, I herewith inclose valuable correspondence on that subject, with particular reference to the letter of Fairbanks & Co., of July 15, 1874, wherein they set forth the utter impracticability of adopting either plan without great liability to mistakes, or the necessity of sending skilled workmen to adjust each scale.

I am, very respectfully, your obedient servant,

D. W. RHODES,
Superintendent.

HON. J. W. MARSHALL,
Superintendent Railway Mail Service.

METRIC SYSTEM.

LETTER FROM THE SECRETARY OF WAR, TRANSMITTING REPORTS OF CHIEFS OF BUREAUS UPON THE ADOPTION OF THE METRICAL SYSTEM, IN RESPONSE TO A RESOLUTION OF THE HOUSE OF REPRESENTATIVES.

DECEMBER 7, 1877.—Referred to the Committee on Coinage, Weights, and Measures, and ordered to be printed.

WAR DEPARTMENT,
Washington City, December 5, 1877.

The Secretary of War has the honor to transmit to the House of Representatives, in response to the resolution of the House of the 6th of November, 1877, reports from the chiefs of bureaus of the War Department relative to the adoption of the metrical system of weights and measures for use in governmental transactions and between individuals.

GEO. W. McCRARY,
Secretary of War.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

[FORTY-FIFTH CONGRESS, FIRST SESSION.]

CONGRESS OF THE UNITED STATES,
In the House of Representatives, November 6, 1877.

On motion of Mr. Clark, of Missouri,
Resolved, That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress, and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States.

Attest:

GEO. M. ADAMS, *Clerk.*

Report from the Adjutant-General.

ADJUTANT-GENERAL'S OFFICE,
Washington, November 10, 1877.

SIR: Referring to the House resolution of the 6th instant, calling on heads of departments for report as to what objections there are, if any, against the adoption of the metrical system of weights and measures, as authorized by act of Congress, referred to this office for early report, I have the honor to reply that, as the use of weights and measures does not fall under this office, it has not the requisite experience on which to form an opinion.

I have the honor to be, sir, very respectfully, your obedient servant,
E. D. TOWNSEND,
Adjutant-General.

THE HONORABLE THE SECRETARY OF WAR.

Report from the Inspector-General.

HEADQUARTERS OF THE ARMY,
Inspector-General's Office, Washington, November 16, 1877.

Respectfully returned to the Secretary of War.
Although I have had no practical experience in the use of the metrical system of weights and measures, yet, in my judgment, the compulsory change from the present system would be inexpedient, as involving a large outlay of money without adequate comparative results.

R. B. MARCY,
Inspector-General.

Report from the Judge-Advocate-General.

BUREAU OF MILITARY JUSTICE,
November 14, 1877.

Respectfully returned to the Secretary of War.

While generally impressed with the excellence of the French metric system, and with the desirableness of adopting a system, on a decimal basis, which shall be common to civilized nations, I have no such expert knowledge of the details or operation of the French system as to enable me to express an intelligent opinion thereon. The subject is one wholly without my official province.

W. M. DUNN,
Judge-Advocate-General.

Report from the Quartermaster-General.

WAR DEPARTMENT,
QUARTERMASTER-GENERAL'S OFFICE,
Washington, D. C., November 10, 1877.

SIR: In reply to the reference of the resolution of the House of Representatives of the 6th instant, in regard to the objections which may exist to making the use of the metric system of weights and measures obligatory, first in all government transactions, and, second, in all transactions between individuals, and the length of preliminary notice desirable before such metric law goes into operation in the United States, I have the honor to say that if the law makes the use of the metric system obligatory in all government transactions, it can be adopted by officers of the Quartermaster's Department as soon as notified by general orders.

Such an order can be distributed to every military post within the space of one month from time of its publication, and, if the telegraph be used, within one week.

The objections thereto, which at once occur to me, are:

1st. It will very considerably increase the labor of computation, for, in practice, all sellers to the United States will make their deliveries in accordance with the English measures now in general use, and the officers, using the ordinary scales for weight, and the yard, foot, and inch, and bushel, gallon, quart, and pint for measures, will first ascertain the quantities and sizes in the present weights and measures, and then, by the use of tables to be distributed, will reduce them to metric quantities in their statement of their vouchers, receipts, and accounts, which will, it appears to me, be perfectly useless labor.

2d. This reduction, involving additional calculations and transfers from one set of units to another, unfamiliar and much less convenient, will infallibly be the source of many mistakes, to the loss of the disbursing-officer of the Treasury, or of the person who sells supplies to the United States.

3d. It will be necessary, in order to make the operation of such a law really successful, to throw away all the hay-scales and other platform-scales whose beams are now divided according to the American standard units of weight, and all the rules and measures divided according to the yard, foot, and inch, and all the weights, pounds, ounces, or grains of avoirdupois, troy, and apothecaries' weight, and to purchase, distribute, and substitute new scales and new weights according to the metric system. These changes will be expensive. The trouble and labor I do not speak of, as such labor will, in case of the passage of a law, simply be the duty of all officers and employés of the United States.

4th. If the metric system is made obligatory in government transactions and not in transactions between individuals, then continual confusion and misunderstanding will be caused by the use of one standard by the government and another by the people. All packages are put up by merchants, manufacturers, and producers in accordance with the actual legal standards, pounds, ounces, grains, yards, feet, inches. The transactions of the United States, large as they are, are insignificant compared with those of private trade. Manufacturers and consumers, and the people will not change their customs at the call of the officers of the United States.

In regard to making the metric system obligatory in transactions between individuals:

1st. I do not believe that this is within the power of Congress. It will be looked upon by the people as an arbitrary and unjust interference with their private business and individual rights, and I do not think that they will submit to it. It will inflict, if it can be enforced, a great loss upon many, especially upon manufacturers and mechanics whose shops are filled with costly tools, standard gauges, dies and machines, all constructed upon the basis of the foot and inch.

Every geared lathe in the United States depends upon a screw of a certain number of threads to the inch, and all the screws it produces are gauged in pitch and diameter by the inch.

The meter is not commensurate with the inch, foot, or yard; all reductions are approximate only. The law of July 27, 1866, makes the use of the metric system permissible, legal, but not obligatory, and establishes for the reduction of meters to inches, and the reverse, the ratio of one meter to thirty-nine and thirty-seven hundredths inches, which is not absolutely correct. To alter all this machinery, to change all these machines, gauges, dies, screws, and other parts of engines, will be the work of years; it will cost millions of dollars.

The metric system is not a convenient one for common use. Its measures are not of convenient length. The yard, half the stature of a man, is of convenient length to handle, to use, to apply. It, and the goods measured by it, can be halved, quartered, subdivided into eighth, sixteenths, thirty-seconds, sixty-fourths, &c.; or it can be with equal facility divided into tenths, hundredths, thousandths. Half a meter is no dimension; half a centimeter is an unknown quantity; but half a yard, half a foot, half an inch, half a bushel, one-fourth of a bushel, of a quart, of a pint, &c., are recognized. If half a liter, of a deciliter, or a quarter, eighth, or sixteenth of these quantities is provided for, then the metric decimal system is abandoned at once.

In calculation the metric system applies admirably to money and accounts of money; but even here the government has been obliged to abandon for the convenience of the people the true, strict, decimal system, and to coin half a dollar, half an eagle, the quarter of a dollar, &c.

In the use of weights and measures, however, there are not so great advantages in the decimal system. The unit is too large, and the numbers produced and used in the calculations of the engineer are tedious to write and are beyond the limits of ready apprehension.

The ciphers and figures 0.00000073 convey no idea to a mind trained in the English and American system, and yet such combinations are common in French works of science and mechanics.

The true scientific natural basis of the metric system has been abandoned. The meter was intended and enacted to be the ten millionth of the quadrant of the terrestrial meridian of Paris. In the progress of geodesy and science, it is ascertained that the standard meter bears no relation to that quadrant, and though it is probably very nearly the ten millionth of the quadrant of the meridian in which New York lies, it is not probable that it is the ten millionth of either of the three other quadrants of that meridian, or of any quadrant of any other meridian.

The fact is, that the meter is quite as arbitrary and unscientific a standard as the foot or yard. It is of less convenient length than either of them, and its compulsory adoption would derange the titles and records of every farm, and of every city and village lot in the United States; would put every merchant, farmer, manufacturer, and mechanic to an unnecessary expense and trouble, and all, it seems to me, for the sake of indulging a fancy only, and a baseless fancy, of closet philosophers and mathematicians for a scientific basis of measures and weights which (as the meter is not a ten millionth of the Paris quadrant, is not what it professes to be, was enacted to be) cannot be found in the French metric system.

1. The unit of length:

The meter is 3.280890+ feet, or 39.37079+ inches.

2. The unit of area:

The are is 119.60332+ square yards.

3. The unit of liquid measure:

The liter is 0.26418635+ gallon, or 1.0567454+ quarts, or 2.1134908+ pints.

4. The unit of space:

The stère is 1.303764+ cubic yards, or 35.386636+ cubic feet.

5. The unit of weight is:

The gram = 15.43234874+ grains troy.

6. The unit of rods is:

The kilometer = 1000 meters = 0.62138+ mile.

7. The unit of land measure for farms and city lots is:

The hectare, 2.47114+ acres.

8. The commercial unit of weights is:

The kilogram = 1000 grams = 2.20462125+ pounds avoirdupois.

What will our farmers, citizens, merchants, tradesmen, mechanics, do with these figures? And will they submit to being obliged to reduce acres, feet, inches, pounds, and ounces by multiplying or dividing by the above figures?

I think that to make the French metric system obligatory between individuals in this country will be an impolitic and arbitrary interference with the rights, interests, and habits and customs of the people.

Very respectfully, your obedient servant,

M. C. MEIGS,
Quartermaster-General, Brig. Major-General, U. S. A.
The Hon. SECRETARY OF WAR.

METRIC SYSTEM.

Report from the Surgeon-General.

WAR DEPARTMENT,
SURGEON-GENERAL'S OFFICE,
Washington, D. C., November 17, 1877.

SIR: In compliance with instructions from your office contained in an indorsement upon a copy of the resolution adopted by the House of Representatives, calling for reports as to objections to making the use of the metrical system of weights and measures obligatory in all government transactions, and also obligatory in all transactions between individuals, I have the honor to report as follows:

I. As to the first of the questions submitted in the resolution, I feel constrained to express the opinion that the gravest inconveniences would immediately result from an attempt to render obligatory upon government officers only the use of a system of weights and measures whose units are so entirely different from those which have heretofore been, and would then continue to be, in general use among the people. I pass by the enormous difficulties which would result from compelling government officers to use a different unit for the *measures of length* from that used by the people. This would not only throw into confusion the whole system of land measurement as practiced in the United States, but would produce the most serious inconveniences from the resulting effort to use in all government works tools and machinery gauged by a different standard from those in common use. These and similar inconveniences, some of them of the most deplorable kind, would be felt so much more severely by other departments of the government that the duty of representing the force of these objections may safely be left to them. I confine myself, therefore, in this report, to a brief statement of the disastrous inconveniences which would result to the medical department of the Army from the measure in question. This measure would compel the substitution of the metric system of weights and measures in prescribing and dispensing medicines in the Army for the system of apothecaries' weights and measures at present in use by the medical profession of the United States.

In all the medical and surgical works of any importance printed in the English language the doses are expressed in apothecaries' weights and measures. The immediate effect of compelling medical officers of the Army to substitute the metrical weights and measures would be to force them to make a series of arithmetical calculations every time they attempt to use the prescriptions or doses laid down in any medical work written in the English language. This thankless and unnecessary labor would waste much precious time, and an error might cost life. Moreover, the strength of the various medical tinctures and solutions in use in England and America has been so adjusted that the proper dose is expressed in even minims, drachms, or fluid ounces. Merely to substitute for these simple quantities the corresponding fractional numbers would be a silly waste of labor; and in order that a proper dose might be expressed in an even number of cubic centimeters, a revision of the Pharmacopœia would be necessary, and this would have to be followed by a corresponding revision of all the medical books in common use before the new Pharmacopœia could be conveniently used. In my opinion the best interests of sick officers and soldiers require that the medical staff of the Army should, in all its operations, act in the most complete harmony with the medical profession of the United States, and I cannot do otherwise than express my belief that the discordance in practice, which would be imposed by such a statute as is suggested, would be fraught with the most unfortunate consequences.

II. As to the second question, while I admit that the enforced introduction of the metric system would produce less detriment to the public service if it were rendered obligatory upon the whole people than if its use were simply compelled in government transactions, I must express the opinion that great public inconvenience would result if at the present time its general use were rendered obligatory by the exercise of an arbitrary act of power. I leave to others to point out the disorders likely to result in the land measurements, the railroad interests, and the general machinery interests of the United States, in all of which the units at present employed are incommensurable with those of the metric system, so that the use of long decimal fractions in the most ordinary transactions would become imperatively necessary as the only road of escape from still greater evils. I confine myself merely to the question of the interests of the medical profession of the United States, and must express the opinion that it will be time enough when they have asked for it to impose upon that body a change which will put all their operations out of harmony with the similar proceedings of other English-speaking nations. For assuredly many of the inconveniences which would be felt by government officers if compelled to use a system of weights and measures not used by the people would be felt by the whole people if they are compelled to use a system so materially different from that employed by other English-speaking people. These inconveniences would only be reduced to the minimum, if, by an international convention between the United States and Great Britain, a mutual agreement were entered into to bring the system simultaneously into use among all

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English-speaking people. Unless some such international arrangement can be effected I think it would be wiser for the friends of the metric system to remain for the present content with the law which has legalized its use by those who may find it well adapted for their own particular work. If it possesses the great advantages claimed for it over the older system, its use being already authorized by law, it will gradually extend until it has crowded all others out of existence, and no further legislation than that already had will be necessary to secure ultimately its general introduction. If, however, its advantages are so far counterbalanced by its disadvantages, at some of which I have briefly hinted, that its use having been legalized, the people will not employ it of their own accord, its enforced introduction would be a great public wrong.

I am, sir, very respectfully, your obedient servant,

J. K. BARNES,
Surgeon-General, U. S. A.

The Hon. SECRETARY OF WAR.

Report from the Commissary-General of Subsistence.

WAR DEPARTMENT,
OFFICE COMMISSARY-GENERAL OF SUBSISTENCE,
Washington, D. C., November 16, 1877.

SIR: In reply to your reference of the 8th instant for my views of a copy of the resolution of the House of Representatives, adopted on the 6th instant on motion of Mr. Clark, of Missouri, requesting the heads of the executive departments of the government to report "what objections, if any, there are to making obligatory, in all government transactions, the metrical system of weights and measures whose use has already been authorized by act of Congress; and also how long preliminary notice should be given before such obligatory use can be introduced without detriment to the public service;" and also "what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States," I have the honor to state, in reply to the first branch of the inquiry covered by the resolution, that to make obligatory, in government transactions, the metrical or any other system of weights and measures not in use by the people, and, consequently, not familiar to or generally understood by them, would not only involve great confusion and great extra labor in making reductions from the system in use by the people to the system adopted for the government, but I believe that the people would look with grave suspicion upon government transactions based on a system of weights and measures which they did not understand; and that to adopt a system exclusively for the government would have a tendency to remove the government farther from the people, and weaken, if not nearly destroy, their confidence in the integrity of the officials and agents of the executive departments.

To the second branch of the inquiry covered by the resolution I would respectfully submit that I not only believe great detriment would ensue from the adoption of the metrical system exclusively for the use of the government, but that it would be, also, inexpedient for the United States to make the system obligatory between individuals, unless in co-operation with Great Britain, with whom we are so intimately connected by language, literature, and commerce.

The change to a new system of weights and measures, based upon units widely different from and incommensurable with those upon which the system now in use is based, must necessarily require a great effort, and should be preceded by a long period of preparation, say twenty years. Even with the most thorough preparation, the change, when made, will bring with it almost inextricable confusion and well-nigh intolerable inconvenience, however superior to the existing system the metrical system may be by reason of its decimal character, its symmetry, and its consequent simplicity.

Very respectfully, your obedient servant,

R. MACFEELEY,
Commissary-General of Subsistence.

The Hon. SECRETARY OF WAR.

Report from the Paymaster-General.

OFFICE OF PAYMASTER-GENERAL, U. S. A.,
November 24, 1877.

Respectfully returned to the honorable Secretary of War.
I am requested to make a report, agreeably to the terms of the resolution of the House of Representatives of November 6, 1877, as to "What objections, if any, there are to making obligatory in all government transactions the metrical system of weights

and measures, whose use has been authorized in the United States by act of Congress; and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service; and that they (heads of executive departments) are also requested to state what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States."

I believe that the eventual introduction into common use of the metrical system is highly desirable, and is fast becoming still more necessary in our intercourse with foreign nations, especially if it is destined, as seems likely, to pervade the world. The great objects attained by it will be, fixed standards, uniformity, and the extension of the decimal system, found so useful in our money standards.

Beginning with France in 1795, the whole continent of Europe has adopted the metric system, with the exception of Russia, the German Empire having adopted it in 1873.

That Germany could adopt a French system so soon after the war with France is honorable to German candor and sagacity, and encourages the belief that England, with all its conservatism, with all its repugnance to any novelties, will yet follow suit, especially considering its commercial necessities.

I am satisfied that it will be advisable to begin first with legislation making the metric system obligatory in certain, not in all, government transactions. In the collection of customs, in the postal system, and in fixing the rates of coinage, and in all international transactions, it should now be made obligatory from the 1st of July, 1879. I do not recommend its adoption in the land system, and in purchases for the Army and Navy, and for the government at so early a date.

By this first proposed legislation a stimulus would be given for the system being taught in all the schools. Thus in six years the rising generation would be initiated and accustomed to it. It would be time enough then for legislation making its use obligatory in all remaining government transactions.

After a full trial of these measures the people might be prepared for its voluntary introduction in domestic transactions and for legislation making it obligatory. But it is desirable that there should be no premature legislation of this last-named character, creating discontent and an unfortunate repeal of untimely laws enacted in advance of public sentiment. The preliminary measures referred to would prepare the public mind gradually for final legislation.

John Quincy Adams, in 1819, advocated the advantages of the metric system, but did not recommend any legislation at that time. But he predicted that the time would come when it would be universally adopted. That prediction is now in process of fulfillment.

By the act of 28th July, 1866 (sec. 3569 R. S.), the use of the system was made legal and the equivalents to present standards announced. And it seems now probable that, by the gradual process I have indicated, the use of the system will finally become acceptable to the people of the United States.

BENJ. ALVORD,
Paymaster-General, U. S. A.

Report from the Chief of Engineers.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., December 3, 1877.

SIR: In obedience to the instructions of the honorable the Secretary of War, indorsed upon the resolution of the House of Representatives of November 6, looking to the early adoption of the French system of weights and measures, I have the honor to submit the following views:

The resolution presents two main inquiries: first, as to the adoption of the metric system in the government offices; and, secondly, as to its adoption in transactions between individuals.

So far as the proposed change would affect the works carried on under charge of the officers of the Corps of Engineers, it need only be said that while any change in the ordinary and accepted standards must be an inconvenience, yet there is no other reason why the change should not be made, provided sufficient time is given for preparation. It is thought that the French metric standards should not be adopted, to the exclusion of the present standards, in this office within a less interval of time than five years after the passage of the act. This limit is fixed as the minimum, in order to allow for the proper careful manufacture, comparison, and distribution of standards, and their duplication in various forms for ordinary use, for the necessary changes in tables and formulæ, and more especially to allow a sufficient interval of time during

which a practical familiarity with the new standards may be acquired, particularly by those with whom the business of the Engineer Department is transacted and who are not in the public service, as well as by those not in the public service who use the maps, charts, &c., of the department.

In regard to the compulsory use of the metric standards in the transactions of individuals, certain additional considerations present themselves. It is to be borne in mind that there is nothing in the proposed change which will in any way favorably affect the usual course of private business in this country, and that the demand for a change from the present system does not come from business men, but is made in furtherance of a project designed for the general public good in international intercourse. There is no pressing necessity for immediate change, and it would undoubtedly be better, if the change should be made, to make it by concerted simultaneous action on the part of all English-speaking people.

The relations of trade between this country and Great Britain are such, that the adoption of new standards of weights and measures by the one without the concurrent action of the other, is extremely undesirable.

As to the general question whether it is desirable to adopt a decimal system of weights and measures, there will probably be but little difference of opinion, since its adoption will to some extent simplify existing tables, and tend to establish a uniformity of practice throughout the world. As an actual practical fact, its adoption is a matter of no immediate importance, and certainly should not be made obligatory upon individuals before it has become generally understood by being adopted in the government service and taught in all public schools.

The French decimal metric system has been adopted and made compulsory in France, Belgium, Holland, Greece, Italy, Spain, Portugal, Germany, Colombia, Venezuela, Ecuador, Brazil, Peru, Chili, and Argentine Confederation and Uruguay.

Great Britain and the United States have legalized the system, but have not made it compulsory. Switzerland, Sweden, Denmark, and Austria use partial decimal systems, but with different units of length and of measure.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

HON. GEORGE W. McCRARY,
Secretary of War.

Report from the Chief of Ordnance.

WAR DEPARTMENT, ORDNANCE OFFICE,
Washington, November 22, 1877.

SIR: I have the honor to acknowledge the receipt of a copy of resolution of the House of Representatives requesting early report of any objections there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized by Congress, &c.

In reply, I herewith inclose the views of Col. T. J. Treadwell, Ordnance Department, and of the Ordnance Board, to whom this subject was referred for report. I concur in these views and conclusions, anticipate little difficulty in the introduction of the metrical system in all ordnance transactions, and deem twelve months' preliminary notice ample.

Very respectfully, your obedient servant,

S. V. BENÉT,
Brigadier-General and Chief of Ordnance.

The Hon. SECRETARY OF WAR.

Maj. T. J. Treadwell's views on the metrical system.

The change from our present system of weights and measures may be very simply made by making the *foot* equal 3 decimeters,* or the *yard* equal 9 decimeters or $\frac{9}{10}$ of a meter. The standard rule for the new system of measurements may be made as follows: Lay off on the rule one meter, take $\frac{9}{10}$ of this length, divide this into three equal parts, subdivide each of these into ten equal parts, and each subdivision into ten equal parts; we would thus have as the standard of length, the meter, the $\frac{1}{10}$, $\frac{1}{100}$, and $\frac{1}{1000}$

* The length 3 decimeters, instead of $\frac{1}{3}$ of a meter, is taken as a substitute of the present part, because its length—11" 81/1237—is nearly that of the foot, and the use of this length would come more naturally than would be the case if the difference between the new and old foot was a very considerable part of its whole length.

of a meter. Make all verniers read to the decimal of this latter subdivision. With the meter thus adopted for a standard unit of measure—

The square meter would be the unit of surface measure.

The cubic meter would be the unit of solid measure.*

The cubic of $\frac{1}{10}$ meter would be the unit of capacity, or liter.*

The cubic of $\frac{1}{100}$ meter would be the unit of weight, or gram.

Introduce the words meter, liter, and kilogram (the gram being 15 grains about, is too small a unit for weight for practical use).

Form all denominations decimal from the primary unit meter, and secondary units liter and kilogram, viz:

1 meter.	$\frac{1}{10}$ meter.	1 liter.	$\frac{1}{10}$ liter.	1 kilogram.	$\frac{1}{10}$ kilogram.
10 meters.	$\frac{1}{100}$ meter.	10 liters.	$\frac{1}{100}$ liter.	10 kilograms.	$\frac{1}{100}$ kilogram.
&c.	&c.	&c.	&c.	&c.	&c.

Thus all measures of weight, dimensions, and capacity are directly derivable from the meter.

It is believed that the introduction and use of the metric system would, when acquired (which could be readily effected), be of great practical value in the operations of the Ordnance Department, and steps for its speedy introduction therein could be taken without delay.

Additional views of Major T. J. Treadwell.

The system of weights and measures proposed being based on the meter, and all the proposed tables of measure and weights being directly derivable from the meter, and the multiples, the higher denominations the tables being 10, and that of the subdivision being formed decimal from the meter, it is thought the spirit of sections 3569 and 3570 of the Revised Statutes of the United States, which were carefully examined in the consideration of the subject, have been strictly adhered to. The standard rule of length proposed, on which all the tables proposed were based, has laid off on it the meter for the purpose of readily measuring multiples of the meter; for the purpose of smaller measures of length, $\frac{1}{10}$ of this length (the meter) is divided into three equal parts; this subdivision, 3 decimeters in length, was taken because it is 11.81237 of our inches, and being so nearly equal in length to the present foot in use, it was thought it would be more readily conceived of and adapted for use than would the measure of the $\frac{1}{10}$ meter, which is 13.123966 + of our inches.

The suggestion of the 3-decimeter division was derived from the work of Prof. F. A. P. Barnard, of Columbia College, on the subject of the Metric System, page 80, the universal introduction and use of which by all civilized nations he is an ardent advocate. Professor Barnard says: "Our foot differs from three decimeters by a very inconsiderable fraction, less than two-tenths of an inch. If we make this slight alteration we are at harmony with all of continental Europe."

This was made the basis of the proposed changes, and in none of the tables derived from the meter base so used are our present measures retained.

For smaller denominations, decimal parts of the meter, the length 3 decimeters was divided into 10 equal parts, 3 centimeters, and then again subdivided into 10 equal parts, 3 millimeters. Perhaps a better division of the length 3 decimeters would be into 30 equal parts, and each of these again into 10 equal parts, which would make the numerator unity and the subdivision centimeters, millimeters, &c. The smallest subdivision of the proposed standard rule would then be the millimeter, a division equal to .0394 inch, and easily read without the use of a vernier.

That all the other tables proposed are also founded upon and directly derivable from the meter does not, it is thought, require further discussion.

Views of the Ordnance Board, United States Army, Lieut. Col. S. Crispin, president, on the metrical system.

The board examined attentively the Revised Statutes referred to by the Chief of Ordnance and consulted the different views expressed by writers on the subject, in making its report, and it still entertains the belief that it has presented a metrical system of weights and measures in conformity with the United States statutes, and having for its basis the French meter using the decimal system in its subdivisions. A decimal of a meter (0.9) decimal subdivided (the meter being the unit), gives of course the same subdivisions as are found in the decimal division of an entire meter, just as much as the proper subdivision of a foot into inches gives the same subdivision as attains in the standard yard.

* Equal to that quantity of distilled water, at its maximum density, which fills these measures.

The intention of the recommendation is to facilitate the introduction of the metrical system by giving calculators and mechanics an easier appreciation, in an ideal point of view, of the values of subdivisions of the meter in comparison with their conceptions of the subdivisions of the ordinary English foot and yard.

In the acquiring of a language, the old think in their own language and speak in the other; the young, however, with their comparatively blank and highly-impressible brains, harmonize thought and expression readily in acquiring a tongue.

The change from the unit of yards to one of meters, involving changes in weights and measures, and affecting every day all the barriers and the calculations of a great nation, is one which should have all the facilities available to ease the change.

As in language, the old will calculate in yards and work in meters.

It is believed that high accord between the ideas of dimensions and the unit or parts of a unit to express them would exist, and no need of aids to help by reference to our present unit will be required for the coming man educated to the use of the metrical unit.

The retention of the idea of foot and yard seems to be important under this view of the case, and it was considered a judicious "aide memoire" to use a rule of that part of the meter-length which approximates the yard, graduated, however, with the metric subdivisions.

When questions arise involving large measurements, necessitating their expression in meters, they will be so noted, but as this latter measure conveys to the English mind (when these occasions arise), distances approximating to the same in yards, there is no reason for any special provision in this regard.

Decimeter-rules (3 decimeters in length) are now in practical use in the United States.

Letter from the Secretary of the Treasury in response to a resolution of the House of Representatives, transmitting certain reports in reference to the adoption of the metric system.

MARCH 28, 1878.—Referred to the Committee on Coinage, Weights, and Measures.

MARCH 29, 1878.—Recommitted to the Committee on Coinage, Weights, and Measures, and ordered to be printed.

TREASURY DEPARTMENT, March 26, 1878.

SIR: I have the honor to acknowledge the receipt of House resolution of November 6, 1877, asking that the heads of the executive departments of the government be requested to report to the House of Representatives, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental and individual transactions the metrical system of weights and measures, whose use in the United States has been authorized by act of Congress, and also how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public interests, &c.

Concerning this matter of inquiry, I am of the opinion that it is not advisable to make the metrical system of weights and measures obligatory in any transactions at present. The law now legalizes and permits that system to be adopted in all cases with the consent of parties.

While the metrical system is undoubtedly the more perfect in theory, the old system of weights and measures is so ingrained upon the business habits of our fellow-citizens that a new system should not be adopted until it is well understood and acquiesced in by the body of the people. I think great confusion, many inconveniences, and much litigation would arise from its hasty adoption. Congress might properly, in any revision of the tariff, adopt this system, stating in the law, however, the equivalents of the old in the metrical system; but even this change would create some embarrassment, and is of doubtful utility.

I submitted the resolution, however, to the Superintendent of the Coast Survey, the chief clerk of the department, and the chief clerk of the Bureau of Statistics for an expression of their respective views on the matter, and I transmit herewith their replies, to which attention is respectfully invited.

Very respectfully,

JOHN SHERMAN,
Secretary.

HON. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

METRIC SYSTEM.

Reply of J. K. Upton, chief clerk of Treasury Department.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, D. C., March 6, 1878.

SIR: In compliance with your verbal request that I present to you, in writing, any suggestions that may occur to me in the matter of the proposed introduction into this country of the metric system of weights and measures, that the same may be transmitted to Congress with your reply to the resolution of the House of Representatives dated November 6, 1877, I have the honor to submit the following:

PRESENT STANDARDS.

The necessity of uniform standards for measuring distances, weights, capacity, and values among people intimately associated is universally acknowledged, and the Constitution of this country has wisely given to Congress the power to fix these standards. This power has not been freely exercised, and consequently there is no uniform or authoritative standards of measurement throughout the country.

In measuring length, the yard, derived from ancient arbitrary standards of England, is an accepted standard. In scientific theory this yard is supposed to rest upon a law of nature. The inch, the $\frac{1}{3}$ of the yard, is said to be contained 39.13929 times in the length of a pendulum that in a vacuum, and at the level of mid tide in the latitude of London, vibrates seconds. It is, in fact, the distance between two points on an actual bar of brass which the law has declared to be a yard, the distance to be taken when the temperature of the bar is at 62° Fahrenheit. This bar was obtained from England in 1827 for the survey of the coast, and is deposited in the office of the Coast Survey in this city. On it has been copied the standard English yard, and it affords a standard which has been adopted by the executive departments of the government and by the several States for all purposes of linear measurements. In practice the yard is variously subdivided and other derivative standards employed.

In the actual government standards at the custom-houses, the yard is divided into tenths and hundredths. Surveyors and engineers employ neither the yard nor the inch, but the foot, the one-third of a yard, and its decimal subdivisions. Mariners measure by the cable-length (240 yards) and fathom (6 feet). Land-surveyors employ the chain (22 yards) and the link (7.92 inches). Artificers and architects reckon by the foot and the inch, subdivided into halves, quarters, and eighths. Muslins and dry goods generally are measured by the yard, subdivided into halves, quarters, and eighths; clock-pendulums by the line ($\frac{1}{2}$ of an inch) and the point ($\frac{1}{2}$ of an inch), and the height of horses is measured by the hand (4 inches).

In measuring weight, the standard for coinage purposes is the troy pound. Like the yard, it is derived from arbitrary standards of England. In 1827 Congress declared a certain brass weight, procured that year by the minister of the United States at London, to be the standard troy pound of the mint of the United States, conformable to which the coinage of the country should be regulated. This pound weight is identical with the troy pound of England. It is assumed to contain 5,760 grains, and investigation shows that 2.458 of these units in brass will be in just equilibrium with a cubic inch of distilled water when the mercury stands at 30 inches in a barometer, and in a thermometer of Fahrenheit at 62°, both for the air and water. A pound avoirdupois contains 7,000 of these grains.

Copies of both pounds have been furnished the several States and adopted by them as standards, thus securing uniformity in standard units of weight. The troy pound used in weighing precious metals is subdivided into the ounce (480 grains), the penny-weight (24 grains), and the grain also is subdivided decimaly. Apothecaries, in compounding medicines, employ the scruple (20 grains), and the dram (60 grains); but in all ordinary commercial transactions the pound avoirdupois is employed, being subdivided into the ounce, (437.5 grains) and the dram (27.35 grains); the ounce being also by usage subdivided into halves and quarters.

A weight called a quarter, consisting of either 25 or 28 pound units, is also used, and a hundred weight is 100 or 112 pound units, and a ton 2,000 or 2,240 pound units, according to the substance weighed and the party weighing it. Coal, for instance, is purchased by the ton of 2,240 pounds and sold by the ton of 2,000 pounds.

In measuring capacity, three units, also adopted from England, are employed—the bushel, the wine-gallon, and the beer-gallon. For measuring fruits, grain, salt, &c., the bushel (2150.42 cubic inches) is used, subdivided into the peck (537.60 cubic inches), the gallon (265.8 cubic inches), the quart (67.20 cubic inches), and the pint, $\frac{1}{2}$ of a quart. This bushel is identical with the old Winchester bushel. The imperial bushel of England now used in that country is equal to 1.03152 of the Winchester bushel. The value of a bushel as a unit of weight will be hereafter considered.

For measuring liquids, except ale, beer, and milk, the wine-gallon, containing 231

METRIC SYSTEM.

cubic inches, is used. It is subdivided into fourths, called quarts, these quarts into halves, called pints, and the pints into fourths, called gills. There is also in this system a barrel of 31.5 gallons, a tierce of 42 gallons, and a tun of two pipes or of eight barrels.

For measuring ale, beer, and milk, the beer gallon, 282 inches, is the unit, divided, like the wine-gallon, into quarts and pints. There is also in this measure the barrel of 36 gallons, the hogshead of 54 gallons, the puncheon of 72 gallons, and the butt of 108 gallons. None of these units are identical with any units of the other capacity measures. To add to the confusion, there are in different parts of the United States a barrel for beer, consisting of 32 gallons; the barrel for corn, of 5 bushels; for fish, of 220 pounds; for flour, 196 pounds; for lime, 320 pounds; and for lamp-oil, 43 gallons. The imperial gallon used in Great Britain contains 277.274 cubic inches, thus differing in size from any gallon used in this country.

In measuring solids, ordinarily the cubic inch, foot, and yard are used as units. In measuring round and hewn timber, tons of 40 and 50 cubic feet are respectively used. For shipping purposes, a ton of 42 cubic feet is used; and in measuring wood, the cord-foot (16 cubic feet) and the cord (128 cubic feet) are employed.

Appended to this report are tables, marked A, B, C, showing the units of each measure and their values in terms of a common unit of the system to which it belongs, and also their equivalents in terms of the metric system.

It will be seen that, in measuring length, twenty-five units are employed, three of which, although under different names, have like values, the others having different names and values, but bearing no useful relation to each other. In measuring weights, eighteen units are employed, three of which are duplicated, as the troy pound, the apothecaries' pound, and the avoirdupois pound, two of which are identical in weight; others have the same name but are of different values. Those duplicated reduce to that extent the number of units for the several purposes, but the fact of their duplication confuses rather than simplifies the system.

In the measurement of capacity, twenty-seven units are employed, though but nineteen have different names. None of these are duplicated, however, except in names; and the gallon has three distinct values, so also have the quart and pint. The bushel appears to have but one value, but in nearly every State and in the customs-tariff of the general government the term is also employed as a unit of weight, the law fixing the number of pounds according to the substance weighed. Table D, herewith appended, shows the value of the bushel under the laws mentioned, prepared from latest information accessible. It will be seen that the most common products of the earth have no uniform standard of measurement. In the contiguous States of Massachusetts, Connecticut, and Rhode Island, a bushel of oats, for instance, is, respectively, 32 pounds, 28 pounds, and 2150.42 cubic inches, and like confusion exists throughout the country.

As no trade restrictions exist between the several parts of the country, the disadvantage of having so common a standard as the bushel mean one thing in one State and another in another is easily seen. But even in local transactions one meets with troy weights, apothecaries' weights, and avoirdupois weights; with long tons, short tons, and shipping tons; with wine gallons, beer gallons, and dry gallons, and with barrels of undefined sizes, making in all an aggregate of appalling confusion.

A system consisting of a single unit for each measure, bearing simple relations to each other and having uniform subdivisions and multiples, would evidently be far superior for all purposes of measurements, local or throughout the States, and if superior for local and national use, it would also be preferable for international purposes, if, at the same time, it should be in harmony with the systems of other countries.

THE PROPOSED STANDARDS.

After several years of investigation, in 1795 France invented and adopted a system under which, for everything susceptible of being measured and weighed, there should be only one measure of length, one of weight, and one measure of contents; their subdivisions and multiples to be expressed decimaly, and all to repose for verification upon a unit of length, which should be an aliquot part of the circumference of the earth. To obtain such a unit, measurements of an arc of a meridian were made, and the length of the quadrant meridian having been obtained, its one ten-millionth part was adopted for the purpose. This unit, equivalent to 39.37 + English inches, is called the meter, upon which are based all other measures constituting what is known as the "metric system."

The gram is the unit of weight, and is the weight of a cube of water of maximum density, each edge of the cube being $\frac{1}{10}$ of the meter.

The liter is the unit for measuring capacity, and is equal to the contents of a cube whose edge is the tenth part of a meter.

The ar is the surface measure, equal to a square whose side is 10 meters.

The ster is a cubic meter used in measuring certain solids. Each of these units is divided decimaly and larger units are formed by proceeding

decimally. The subdivisions are designated by the prefixes *deci*, *centi*, and *milli*, and the successive multiples by *deka*, *hecta*, *kilo*, and *myria*, each having its own significance and no other.

The adoption of this system in the United States is now proposed. Compared with our existing systems, its superior advantages would seem to consist (1) in having an invariable standard taken from nature; (2) in having a single unit for all weights and a single unit of measures of capacity for all substances, wet or dry; (3) in having decimal subdivisions and multiples of its units; and (4) in the uniformity, precision, and significance of its nomenclature.

(1.) The only advantage of having the unit an aliquot part of the earth's polar circumference would appear to be in its application to geography and astronomy. But the dividing of the quadrant of the meridian decimally into hundreds and thousands, as proposed, has been found impracticable and the project has been abandoned. To that extent the metric system has proven a failure. Recent experiments have also demonstrated that the length of the quadrant meridian was not accurately ascertained at the time of the adoption of the metric system, and consequently the actual meter established is not the aliquot part of the meridian, as supposed. Future investigations may eliminate other errors of calculation and again change the theoretic standard. For all practical purposes a platinum rod kept in Paris is the standard meter, and it has no special advantage over that of the brass rod kept in London for a standard yard.

(2.) In having one unit for weights and one unit for all measures of capacity, the metric system enjoys a superiority over all others. To the English system belongs two measures of weight, the troy pound and the avoirdupois pound; and three measures of capacity, the wine-gallon, the beer-gallon, and the bushel, containing eight dry gallons. This diversity of measures originated in an effort to make a measure of capacity also a measure of weight; for instance, a gallon of wheat and a gallon of wine each to weigh eight pounds avoirdupois. But the effort failed, and the law long ago fixed the dimensions in cubic inches only.

The metric system has only one measure of weight and one measure of capacity, and experience has proved these to be sufficient for all purposes desired.

(3.) To the English system belongs also the disadvantage of an irregular scale of progression between units of the same measure. In measures of length we ascend by the factors 12, 3, $5\frac{1}{2}$, 40, 8, 3, or else by 7.95, 25, 4, and 80. In weights we have three series, avoirdupois, troy, and apothecaries, the common unit being the grain. In the first, the factors are $27\frac{1}{2}$, 16, 16, 25 or 2 $\frac{1}{2}$, 4, and 20; in the second, 24, 20, and 12; and in the third 20, 3, 8, and 12. The factors in other measures are equally as various. To learn these many scales of unequal progression requires much time and labor, which can be better applied to other purposes.

In the metric system, however, we ascend and descend in all cases by the common factor 10, thus placing the system for all purposes of calculations upon the basis of simple numbers. The decimal system in numeration has already asserted and maintained itself, and to it has given way one by one the schemes of different nations. In countries where not adopted it is frequently used. Even in England, where pounds, shillings, and pence constitute the currency of the country, merchants count in cents their interest, discount, and dividends. Slowly, but surely, all standards of measurement are in practice being divided into tenths and hundredths. The decimal system, once adopted, has in no instance been abandoned; and whether we will or not, it will ultimately prevail to the displacement of all other systems.

(4.) In the English system of weights and measures there are also found 74 units in common use, having 56 names. The ounce, the drachm, and the grain are indefinite parts of an indefinite whole. The pound avoirdupois is heavier than the pound troy, but the ounce avoirdupois is lighter than the ounce troy. In the confusion numbers even lose their identity. A dozen, for instance, may mean sixteen; twenty-eight signify twenty-five; and one hundred and twelve a hundred; thus making the whole less than the sum of its parts. A gallon of wine is not so much as a gallon of milk, and a ton of coal is sometimes one weight and sometimes another. The bushel for measuring products of the earth has 130 different sizes in this country, and none of them of the size of the bushel of England, to which country most of our surplus products are shipped in quantities measured by bushels.

In the vocabulary of the metric system there is but one word to denote a unit of length, one to denote a unit of weight, one for a unit of capacity, one for surface, and one for cubic measurements, and the words have no other significance. Thus the word meter means an established unit of length and nothing else. It cannot be the measure of one length in one country and of another length in another country. The gram is a specific weight everywhere and under all conditions the same, and the liter denotes a vessel of specific cubic contents for the measurements of all liquids, and is never used for any other purpose.

The multiples of these units are denoted by prefixing to them respectively four syllables from the Greek language, indicating decimal progression; the subdivisions, by prefixing four syllables from the Latin language, indicating decimal fractions, and

thus five words indicating units and seven prefixes indicating numbers make up the vocabulary of the system. Of whatever superiority, however, the metric system may be possessed, to make its use obligatory by law for public purposes and in transactions between individuals will be a harsh exercise of legislative authority.

Weights and measures have been aptly ranked as necessities of life, and no system of them, however objectionable, can be wholly eradicated, except by long periods of time.

Appalled at the prospective confusion which the abolition of our existing system would bring into every household in the land, John Quincy Adams, after an exhaustive review of the whole subject, advised Congress in 1821 to take no steps with a view of such abolition, and, while he eulogized in glowing terms the merits of the metric system, he could only recognize the system as an experiment, and its adoption, at best, a matter of doubtful expediency. Since that day, nation after nation has, by imperative law, abolished its system of weights and measures, and substituted the metric system, with only the best results. Throughout the civilized world, and even in pagan lands, this system has found recognition and welcome. At the risk of tediousness, I beg to set forth in detail a statement showing its wonderful expansion.

AMERICA.

ARGENTINE REPUBLIC.—(*Until 1823 with Uruguay.*)—The metric system of weights and measures introduced for customs purposes according to the customs-tariff laws of 7th October, 1872, and 11th October, 1873, and is used in the assessment of duties.

BOLIVIA, REPUBLIC OF.—(*Once South Peru.*)—Weights and measures the same as in Peru, which see.

The coin-weight, at least since 1871, is the French gram.

BRAZIL.—(*Rio de Janeiro and Pernambuco.*)—Since January 1, 1874, the weights and measures of Brazil are the French metric.

An imperial decree of 26th July, 1872, approved a law voted by both chambers upon the introduction of the metric system, which, after a permissive use of ten years, should be generally in force. According to a decree of 18th September, 1872, the new system went into obligatory effect, with 1st of July, 1873, a delay of half a year, however, to be allowed for the execution of the decree; therefore, with the 1st of January, 1874, the metric system is definitely established with all its consequences, and since this time only metric measures and weights are used. Diamonds, however, are still permitted to be sold according to the old Portuguese *outara*.

The French meter has already for many years been commonly employed for manufacture, but often, as *now*, the English yard is used, and sometimes the old Parisian *ancme*. Stone-coal is sold, at wholesale, by the English ton of 2,240 pounds, avoirdupois—the *tonelada*—reckoned equal to 70 arrobas, old weight; so, also, bone-ashes; also, ships' freights are, for the most part, settled according to the English ton.

The interval from the date of the decree of 26th July, 1862, introducing the system, to that of the 18th September, 1872, declaring the use of the system obligatory, is nine and two-thirds years; from the earlier date to 1st July, 1873, is eleven years, and to 1st July, 1874, the date from which its use is obligatory, twelve years.

CHILI, REPUBLIC OF.—(*Santiago de Chili.*)—A law of 29th January, 1848, introduced the French metric system of weights and measures. For coin-weight the system came at once into use, but for other purposes its enforcement was delayed.

By a decree of the President of the Republic of 31st May, 1862, and a decree of the administration of 19th December, 1862, the system came into force for customs purposes from 1st January, 1863.

The interval from the date of the law introducing the system to its enforcement for customs purposes was fifteen years.

In trade and for the purposes of common life the old system is generally employed.

Silk and woolen goods are sold by the *rera*; sugar by the *arroba*. Stone-coal is sold by the ton (*tonelada*) of 1,000 kilograms; copper ore by the 100 kilograms; pig-iron is sold by the Spanish ton (*tonelada*) of 20 quintales (920 kilograms); so, also, is guano.

COLOMBIA, in its broader sense.—(*Republic of Colombia, 1822 to 1831.*)—The three republics, now constituting Colombia :

1. United States of Colombia (formerly the confederation of New Grenada, until 1863; before that, the Republic of New Grenada, until 1859).

2. Ecuador.

3. Venezuela.

UNITED STATES OF COLOMBIA.—(*Bogota; Santa Fé de Bogota.*)—In conformity with the law of 8th June, 1853, the French metric system has been in force since 1st January, 1854 (including for shipping). For coinage the weight has been the French gram since 1848. This law introducing the metric system is still permissive for *private* persons and is used at pleasure in their extensive business transactions. Consequently in large transactions the old standards are also used.

ECUADOR, REPUBLIC OF.—(*Quito, or Francisco de Quito.*)—According to the laws of

5th December, 1856, the metric system has been that of the republic since 15th October, 1866 (ten years). Since the last-mentioned date the metric system alone appears in *official transactions*.

A later law, that of 14th April, 1857, again orders the use of the metric system generally in all business transactions throughout the republic.

According to the law of 1856, once in every two years, on the 15th October, the weights and measures of each of the provinces, districts, and communes of the republic must be verified.

GUATEMALA.—(*Central American States; Guatemala, San Salvador, Honduras, Nicaragua and Costa Rica.*)—In Guatemala and Costa Rica, since 1858, the French metric system is legally in force, and in San Salvador the French weight, at least for coin purposes, which also in Honduras, since 1869, is employed as the coinage weight; but in fact in Guatemala and Costa Rica the old Spanish-Castilian system is in use and controls, as well as in the other Central American States.

MARTINIQUE.—(*A French Antilles island in the West Indies.*)—French weights and measures (metric) legal, yet other systems are much in use, the old Parisian and the English.

MEXICO.—The weights and measures of the States of the republic are legally the French metric. A decree of President Commonfort of the 15th March, 1857, ordered their introduction; requiring that *six months* after the date of the proclamation they be exclusively used in all governmental transactions (which was not done), and from 1st January, 1862, should be obligatory for all the inhabitants.

The law of the 15th March, 1861, ordered anew the exclusive use, for all purposes, of the French system of measures, from 1st January, 1862, but this law appearing to remain almost without effect for private working, an imperial decree was issued in November, 1863, again declaring the use of this system alone valid (or in force) throughout all the States.

The use of the new system appears to be extending to more and more places, but least in the wholesale trade (1873), the old weights and ell-measures being still employed.

The new measures retain the names of the corresponding old with the prefix "new."

PERU, REPUBLIC OF.—(*Lima.*)—The weights and measures of Peru are legally the French metric.

The introduction of the metric system has for many years been ordered, but as yet almost wholly without effect.

Later, in the year 1863, its adoption was again ordered, and for customs purposes it is in use. In general, the earlier or old Spanish-Castilian system, with some exceptions and peculiarities, is used. For coin weight the French gram (metric) is used.

UNITED STATES OF AMERICA.—The French metric system of weights and measures rendered permissible by law of 28th July, 1866. To the 5-cent copper nickel-piece was given the metric weight of 5 grams (77.16 grains), by law of 16th May, 1866. To the silver coins of the United States of smaller denominations than one dollar was given metric weights, by the law of 12th February, 1873. For postal purposes one-half ounce equals 15 grains, and so on in progression.

URUGUAY, REPUBLIC OF.—(*Montevideo.*)—(*Oriental Republic of Uruguay.*)—French metric system of weights and measures legalized by decree of 26th March, 1862. This system is in use for customs purposes, but for other purposes does not appear to have been brought into common use. It is employed to some extent for coinage.

VENEZUELA, REPUBLIC OF.—(*Caracas.*)—In the year 1872, through an executive order of 18th July of that year, the French metric system was introduced, in conformity with which already, since the beginning of the year 1873, entries for customs settlements are required to be made.

Coin weight is the French gram (metric), in conformity with the coin law of 30th May, 1848. The weights and measures have been *legally* for many years (about ten years prior to 1874) the French metric, but in practice the metric system had found no place, and even the customs tariff of 12th May, 1867, took the earlier system of weights and measures as its basis. According to a governmental decree of 17th September, 1869, the metric decimal system was to be brought into use in all the customs transactions of the republic, and likewise by the consuls of the State in certifying goods and manifests.

EUROPE.

AUSTRIA.—In conformity with the law of 23d July, 1871, the French metric system of weights and measures was made obligatory from the 1st of January, 1876. The interval from the date of the authorizing law to the date from which it was made obligatory was about four and a half years.

BELGIUM.—(*Antwerp.*)—The metric system of weights and measures was introduced with old denominations during the union of Belgium with the Netherlands—that is, by the law of 21st August, 1816, and the royal decrees of 29th March and 30th November, 1817. By a Belgian law of 18th June, 1836, these names were withdrawn and

French names introduced. A law of 1st October, 1855, created from 1st January, 1856, the exclusive use of the French system (including also the French medicinal weight).

DENMARK.—The unit of commercial weight since the law of May 1, 1863, is the pfund of 500 grams or the one-half kilogram. The unit of coin weight, in conformity with the Scandinavian coin convention of 18th December, 1872, and the law of 23d May, 1873, has been since 31st May, 1874, the metric gram; the convention to be in force until the end of December, 1884—ten years. The introduction of the complete metric system of weights and measures is in prospect.

On the 3d of October, 1876, the minister of interior recommended to the Parliament a project of a law according to which the use of the metric system of weights and measures was to be permissible for three years, after which its use should be compulsory throughout the kingdom. The coin weight, under the coin law of 4th June, 1873, is the French metric, the kilogram.

FRANCE.—The system of weights and measures known by common consent as the "metric system" was proposed by the Prince Talleyrand, then bishop of Autun, in the year 1790. This system was declared the only system of weights and measures in France and in the French colonial possessions by the law of 1st of August, 1793.

The organizing law for the new measures and coins of the metric system was adopted on the 7th of April, 1795.

Under the organizing law of 7th April, 1795, and supplemental law of 15th August, 1795, money is reckoned since 1st July, 1796, and definitely since the coin law of March 28, 1803, in francs of one hundred centimes.

The metric system of weights and measures was definitely introduced through the law of 10th December, 1799, the organizing law, as before mentioned, bearing date 7th April, 1795.

For small or retail trade the "système usuel" was introduced and permitted through decree of February 12, 1812, and the order of the minister of the interior, of 28th March in the same year, and was allowed to continue in use until by the law of 4th July, 1837, its use was forbidden from 1st January, 1840. Although forbidden from this date, the "système usuel" was actually much in use as late as 1861.

The interval from the antecedent organizing (constitutive) law of 7th April, 1795, and the law definitely introducing the metric system of weights and measures into France of 10th December, 1799, is four years and eight months.

The interval from the decree of 12th February, and the ministerial order of 28th March, 1812, permitting the temporary use of the so-called "système usuel," and 1st January, 1840, the date from which its use was forbidden, is nearly twenty-eight years. (Twenty-seven and three-fourths years.)

The interval from the date of the law of 4th July, 1837 (interdicting or forbidding the use of the "système usuel" after the close of the year 1839), to 1st January, 1840, the date from which the use of the complete or pure metric system was made compulsory, was two and a half years.

GERMANY.—The customs pound (500 grams), the standard customs weight of the Customs Union, became the national weight on 1st July, 1858, throughout the greater part of Germany, and for a shorter time throughout the present empire.

It was also made the postal weight of the German Postal Union, and the railroad weight (for freight) of the Customs Union, and since February, 1852, the customs weight of the Austrian Empire, and through the Vienna coin treaty of 24th January, 1857, the coin weight in nearly all the German States, and also in Austria.

A decree relative to weights and measures for the North German Union was promulgated 17th August, 1868. This decree made the use of the metric system of weights and measures permissible from 1st January, 1870, and compulsory from 1st January, 1872. By a subsequent law of the German Empire, the same was re-enacted and extended throughout the realm. Bavaria adopted it by a law of 29th April, 1869.

The interval from the date of the decree for the North German Union to the date when the use of the system became obligatory was three and one-third years; and from the date of the law of Bavaria to its compulsory use was two and two-thirds years.

In Rhenish Bavaria the metric weights and measures were introduced in the year 1840. Outside of the Rhenish provinces the system was non-metric until the metric system was declared optional from 1st January, 1870, and obligatory from 1st January, 1872.

In Baden, the weights and measures made commensurable with the metric system by law of November, 1810, came gradually into use, until, by order of 21st August, 1828, their use was made compulsory with the year 1831, except as regards medicinal weights, which have been metric from July 1, 1864.

In the Grand Duchy of Oldenburg, until the end of 1871, the system of weights and measures in different places differed. Only the metric weight by the law of 19th June, 1857, was made common from and after 1st July, 1858, an interval of one year. In Lubeck this weight was introduced later.

For customs purposes the new pound ($\frac{1}{2}$ kilogram) and the centner (50 kilograms) have been used in all the States of the German Zollverein (Customs Union) since 1st Janu-

ary, 1854, divided, however, as to the pound, into thirty loth. From the same date the pound ($\frac{1}{2}$ kilogram), divided into thirty loth, was adopted by the German-Austrian Zollverein for postal purposes.

By a union of several of the German States the metric pound and the centner were adopted in 1856. Since 24th January, 1857, the coin pound of 500 grams has been employed for the purposes of coinage. Metric medicinal weight has been used since 1858.

GREAT BRITAIN.—The French metric system of weights and measures is permissive by law of 1864.

GREECE.—(Athens.)—French metric system of weights and measures introduced by law of 28th September, 1836, but with the common Grecian names. In the Ionian Islands, however, the English weights and measures have been legalized since 1829.

HUNGARY.—The use of the new Austrian (metric) system of weights and measures was made permissive from 1st January, 1873, and obligatory from and after 1st January, 1876, an interval of three years. Article VIII, of the law of 1874, provided for the introduction of the new metric system, to be in force January 1, 1876.

ITALY.—Since the establishment of the Kingdom of Italy (17th March, 1861), the weights and measures are the French metric. This system has been compulsory over the Italian peninsula and Sicily since 1st January, 1853. It was introduced into Lombardy and Venice, when under the French dominion, in the year 1803, but came into permanent use only for governmental or administrative purposes. On the island of Sardinia it has been in legal use since 1st January, 1846; in Genoa since 1st March, 1847; in the rest of Piedmont since 1st April, 1850; in the continental part of the former Kingdom of Naples since 1st January, 1861. In the earlier Papal States its introduction was ordered in 1845 to take effect from the year 1850, but prior to the end of 1870 has not been much employed.

The former Duchy of Parma, since 1854, the Austrian (or German) customs-weight (the pound of 500 grams) has been employed for customs purposes. In Leghorn the metric weight for wholesale purposes has been still longer in use. In the former Duchy of Modena the metric system of weights and measures was introduced first in 1808, and re-established in 1849.

NETHERLANDS.—The French metric system of weights and measures was introduced by the law of 21st August, 1816, and the royal decrees of 29th March and 30th November, 1817. The length measure to be in force since 1821; square and field measure since 1821; fluid measure since 1830; commercial, medicinal, and apothecaries' weight since 1821.

The metric system established by the law of 1816 and decrees of 1817 applied the old designations to the metric units. The law of 7th April, 1839, established from the commencement of the year 1870 a new series of international names, with the optional use for the first ten years of the old denominations.

NORWAY.—In the Norwegian Parliament, on the 22d of April, 1875, the government moved for the introduction of the metric system of weights and measures.

PORTUGAL.—The French metric system of weights and measures compulsory since 1st October, 1868. Metric measures of length and surface have been legally in use in Lisbon since 1st January, 1860; in the provinces since 1st March, 1860; for capacity and weight throughout the whole land since the end of 1862. For customs, tonnages, warehousings, and the assessment of taxes, the French system has been in force in Lisbon and Oporto since September, 1860; so also for the measurement of shipping by a decree of 25th August, 1860.

ROUMANIA.—(Bucharest.)—According to a royal edict of 27th November, 1874, the government is charged with the duty of introducing the new or French metric system of weights and measures, but its use is not yet accomplished. For railroad purposes they reckon according to the French kilometre.

SWEDEN.—The French system of weights and measures will be obligatory with the year 1883, permissive during the years 1881 and 1882; and for customs and postal purposes, also for railroad transportation, obligatory from the commencement of 1881.

The coin weight is in conformity with the Scandinavian coin convention of 18th December, 1872—the French metric. The medicinal and apothecary weight is the French metric gramme weight, in conformity with the law of 1864.

SPAIN.—(Madrid.)—French metric weights and measures, introduced by a law of 19th of July, 1849, to go into operation in November, 1852. For a portion of the provinces the new system was in force on the 1st January, 1855, and in all Spain, from 1st January, 1859.

SWITZERLAND.—By agreement or convention of 17th August, 1835, known as the "Maass concordats," entered into between twelve Swiss cantons, other cantons, joining later, a modified form of the metric system was established, to go into operation generally with 1st January, 1840, an interval of four and a half years, but in Lucerne in the year 1838, an interval of two and a half years.

The federal law of 23d December, 1851, introduced for the whole of Switzerland the

system of the "Maass concordats" of 17th August, 1835, to be in force in all the cantons at the latest by December 31, 1856, an interval of five years. The facts are that almost everywhere it has been enforced since 1st January, 1853, an interval of one year; in Neufchâtel, however, since March 1, 1858, an interval of six years. In June, 1868, the federal council by law made the use of the *pure* metric system *optional* side by side with the present system of the "Maass concordats."

ASIA.

BRITISH EAST INDIA.—(Calcutta.)—In the year 1859 the British East India Government recommended the introduction of the French metric system of weights and measures, but as yet without result.

An act to provide for the ultimate adoption of a uniform system of weights and measures of capacity throughout British India was passed by the governor-general of India in council in 1871. The act orders:

"ART. 2.—The primary standard of weight shall be called a *ser*, 'a weight of metal equal when weighed in a vacuum to the weight known in France as the *kilogramme*.'

"ART. 3.—The units of weights and measures of capacity shall be, for weights, the said *ser*; for measures of capacity, a measure containing one such *ser* of water at its maximum density, weighed in a vacuum.

"ART. 4. * * * Every weight or measure of capacity other than said units 'shall be an integral multiple or integral submultiple of one of the units aforesaid.'

Unless otherwise ordered "the subdivisions of all such weights and measures of capacity shall be expressed in decimal parts."

The use of metric weights and measures is permissive, and the local governments are empowered to make it compulsory at discretion.

TURKEY.—(Constantinople.)—The French metric system of weights and measures introduced by the organizing law of September, 1869, to go into effect for all purposes in the administration of the empire from March, 1871. Its use optional to the public from March, 1871, to March, 1874, from which date its use was to be obligatory.

The interval from the date of the organizing law to the use of the system for purposes of the government is one and a half years, and the interval from the date when made permissive to that when made generally obligatory is four and a half years.

JAPAN.—Weights and measures in general are non-metric, but for coinage, in part, the metric unit of weight is employed. "The gold yen, the unit of account, contains of fine gold one grain and a half and weighs one grain and two-thirds, being of nine-tenths fineness," consequently the decagram of gold of the ordinary standard of nine-tenths fineness is equivalent in value exactly to six yens. It is stated to be the intention of the government to introduce into Japan at an early period a new system of weights and measures based on the decimal system of France.

AFRICA.

EGYPT.—In July, 1875, the introduction of the metric system of weights and measures was ordered. For coinage, the gramme-weight has already for some time been in use. For a measurement of shipping, the Turkish, the metric ton of 1,000 kilogrammes, is used.

FRENCH COLONIES.

ALGIERS.—Since March 1, 1843, the metric system of weights and measures is legalized. The use of the older system is strongly forbidden, but it continues to a great extent in use.

REUNION, ISLE OF (formerly Isle of Bourbon, and from 1809 to 1814 Isle of Bonaparte), **Africa.**—Weights and measures, the old Parisian, but more and more the new metric coming into use. The metric weight, the half kilogramme, has for many years been in general use.

SENEGAMBIA (Africa).—In the French Senegal colony, by a decree of 15th June, 1826, the use of the old weights and measures is forbidden, with the exception of capacity measures for fruit, and the French metric system introduced.

To us, then, the metric system is no longer an experiment. Already its use is obligatory in Belgium, France, Germany, Greece, Netherlands, Italy, Portugal, Roumania, Spain, and Switzerland; in the Argentine Republic, Brazil, Peru, San Domingo, United States of Colombia, and Uruguay—countries aggregating a population of 181,000,000—while its use is partial or legalized in Austria, Azores, Maderia and Cape de Verde Islands, Central American States, Denmark, Japan, Sweden, Norway, Turkey, Spanish Possessions, Great Britain and the British Possessions, and our own country, aggregating a population of 375,000,000 more.

In view of these facts the obligatory use of the metric system in this country seems feasible, and, in my opinion, it is desirable. Not only will such use bring about a complete uniformity of standards throughout the country, but the system will prove especially valuable for international purposes.

From table E, herewith appended, it will be seen that for the year ending June 30, 1877, the value of our imports from countries where the metric system is obligatory amounted to \$177,807,469; partially in use, \$17,378,735; legalized, \$265,211,585; not legalized or in use, only \$23,804,140. Of the amount received from countries where its use is legalized, Great Britain and British Possessions furnish \$185,667,400. With these countries our present system is partly in harmony, but unfortunately the bulk of our trade with them, as before stated, is made up of articles measured by the bushel and gallon, neither of which standards corresponds to any bushel or gallon of this country. It should be borne in mind that the only legalized system of weights and measures in this country to-day is the metric system, and that this system is the only one we possess in harmony with that of any other country.

Of the time necessary for the government and the people to prepare for its obligatory use there may be some diversity of opinion. Considering the experiences of other nations and the admitted aptness of our people for adapting and utilizing improved methods of business, I am clearly of opinion that a notice of two years will be sufficient to enable the government to prepare for the adoption of the system in all administrative transactions, and that a notice of ten or fifteen years will be sufficient to enable the country to prepare for its obligatory use in transactions between individuals. Possibly, for a while thereafter, a compromise with vulgar fractions and existing terms may be necessary, but meanwhile the new system will be taught in our schools, explained in the public press, and exemplified by our experience, and in a comparatively brief time the use and terms of the old system will disappear as have those of English money before the advance of our decimal coinage.

Very respectfully,

J. K. UPTON,
Chief Clerk.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

A.—Table of the usual measures of length, exhibiting the number of inches in each denomination and their equivalents in terms of the metric system.

One meter = 39.370432 inches; * one inch = 0.025399772 meter; one inch, approximately 0.0254 meter.

* This value of the meter was adopted by the United States Coast Survey on the report of a new determination by Colonel Clark, of the British Ordnance Survey. It has since been rejected by Astronomer Royal Airey, chairman of the British Standards Commission.

1 point	==	$\frac{1}{72}$ inch	==	0.000353—	meter.
1 line	==	$\frac{1}{144}$ inch	==	0.002117—	meter.
1 barleycorn	==	$\frac{1}{32}$ inch	==	0.008467—	meter.
1 nail	==	$\frac{1}{24}$ inches	==	0.057149—	meter.
1 palm	==	3 inches	==	0.076199—	meter.
1 hand	==	4 inches	==	0.101599—	meter.
1 link	==	7.92 inches	==	0.201166—	meter.
1 span	==	9 inches	==	0.228598—	meter.
1 quarter	==	9 inches	==	0.228598—	meter.
1 foot	==	12 inches	==	0.304797—	meter.
1 cubit	==	18 inches	==	0.457196—	meter.
1 ell (Flemish)	==	27 inches	==	0.685794—	meter.
1 yard	==	36 inches	==	0.914392—	meter.
1 ell (English)	==	45 inches	==	1.142990—	meters.
1 ell (French)	==	54 inches	==	1.371588—	meters.
1 fathom	==	72 inches	==	1.828784—	meters.
1 rod, perch, or pole	==	198 inches	==	5.029155—	meters.
1 double rod or half chain	==	396 inches	==	10.058310—	meters.
1 chain	==	792 inches	==	20.116619—	meters.
1 tally	==	3,960 inches	==	100.583097—	meters.
1 furlong	==	7,920 inches	==	201.166194—	meters.
1 cable length	==	8,640 inches	==	219.454033—	meters.
1 mile	==	63,360 inches	==	1,609.329554—	meters.
1 league	==	190,080 inches	==	4,827.988662—	meters.

B.—Table of the usual measures of weight, exhibiting the number of grains in each denomination and their equivalents in terms of the metric system.

One gram=15.43234574 grains; one grain=0.0647985036 gram; one grain, approximately 0.0648 gram.

1 troy grain	==	1	grain =	0.064799	gram.
1 apothecary grain	==	1	grain =	0.064799	gram.
1 avoirdupois grain	==	1	grain =	0.064799	gram.
1 scruple	==	20	grains =	1.295079+	grams.
1 pennyweight	==	24	grains =	1.555175—	grams.
1 drachm (avoirdupois)	==	27.344	grains =	1.771846—	grams.
1 drachm (apothecary)	==	60	grains =	3.887937+	grams.
1 ounce (avoirdupois)	==	437.5	grains =	28.349541—	grams.
1 ounce (apothecary)	==	480	grains =	31.103496+	grams.
1 ounce (troy)	==	480	grains =	31.103496—	grams.
1 pound (troy)	==	5,760	grains =	373.241954—	grams.
1 pound (apothecary)	==	5,760	grains =	373.241954+	grams.
1 pound (avoirdupois)	==	7,000	grains =	453.592653—	grams.
1 quarter (25 lbs. av.)	==	175,000	grains =	11,399.816313+	grams.
1 quarter (28 lbs. av.)	==	196,000	grains =	12,700.594271—	grams.
1 hundred-weight (cental)	==	700,000	grains =	45,359.265252+	grams.
1 hundred-weight (112 lbs. av.)	==	784,000	grains =	50,802.377082+	grams.
1 ton (2,000 lbs. av.)	==	14,000,000	grains =	907,185.30504+	grams.
1 ton (2,240 lbs. av.)	==	15,680,000	grains =	1,016,065.541645—	grams.

C.—Table of the usual measures of capacity, exhibiting the number of cubic inches in each denomination and their equivalents in terms of the metric system.

[One liter or cubic decimeter=61.02538677 * cubic inches; one cubic inch=0.0163866227 cubic decimeter.]

	Cubic inches.	Liters or cubic decimeters.
1 minim	0.0038—	.0000616—
1 fluid-drachm	0.226—	.0036966—
1 fluid-ounce	1.805—	.029573—
1 gill (wine measure)	7.219—	.118201—
1 pint (wine measure)	24.875	.473164—
1 pint (dry measure)	33.6	.550596—
1 pint (beer measure)	35.25	.577628+
1 quart (wine measure)	57.75	.946327+
1 quart (dry measure)	67.2+	1.101191+
1 quart (beer measure)	70.5+	1.155257—
1 gallon (wine measure)	231	3.785310—
1 gallon (dry measure)	268.8+	4.404765+
1 gallon (beer measure)	282	4.621028—
1 peck (dry measure)	537.6+	8.809530+
1 bushel (dry measure)	2,150.42	35.238121+
1 firkin (beer measure)	2,538	41.589248+
1 barrel (wine measure)	7,276.5	119.237260+
1 tierce (wine measure)	9,702	158.983013+
1 barrel (beer measure)	10,152	166.356994—
1 hogshead (wine measure)	14,553	238.474520+
1 hogshead (beer measure)	15,928	249.535490+
1 puncheon (wine measure)	19,404	317.966027—
1 puncheon (beer measure)	20,304	332.714967+
1 pipe (wine measure)	29,106	476.949040+
1 butt (beer measure)	30,456	499.070981—
1 tun (wine measure)	58,912	953.898081—
1 chaldron (dry measure)	77,415.12	1,268.572363—

* This value calculated from Clarke's determination of the meter in inches differs from the values calculated by Captain Kater, which is the standard in England.

D.—WEIGHT OF A BUSHEL.
Revised table showing the States and Territories of the United States and other communities, grains and other commodities, by law the weight in pounds avoirdupois of a bushel of different

METRIC SYSTEM

METRIC SYSTEM.

In addition to the articles named in the above table, the following weights per bushel of the following articles are established by law in the States indicated, viz: Coke: Pennsylvania, 40 pounds to the bushel; Ohio, 40 pounds to the bushel; Iowa, 38 pounds to the bushel.

Hominy: Massachusetts, 50 pounds to the bushel; Ohio, 60 pounds to the bushel.

Pease, ground: Georgia, 25 pounds to the bushel; Kentucky, 24 pounds to the bushel.

Parsnips: Connecticut, 45 pounds to the bushel; Wisconsin, 44 pounds to the bushel; Montana, 50 pounds to the bushel.

Ruta-bagas: Maine, 60 pounds to the bushel; Connecticut, 60 pounds to the bushel; Wisconsin, 56 pounds to the bushel.

Mangold-wurzel: Maine, 60 pounds to the bushel; Connecticut, 60 pounds to the bushel; Washington Territory, 50 pounds to the bushel.

Vegetables, not specified: Rhode Island, 50 pounds to the bushel; Washington Territory, 50 pounds to the bushel.

Onion top sets: Virginia, 28 pounds to the bushel; Nebraska, 25 pounds to the bushel.

Dried fruit—Plums: Michigan, 28 pounds to the bushel.

Peaches, peeled: Virginia, 40 pounds to the bushel; Georgia, 38 pounds to the bushel.

Currauts, gooseberries, and grapes: Iowa, 40 pounds to the bushel.

Other berries: Rhode Island, 32 pounds to the bushel; Michigan, 40 pounds to the bushel; Iowa, 32 pounds to the bushel.

Chestnuts: Virginia, 57 pounds to the bushel.

Peanuts: Virginia, 22 pounds to the bushel.

Seeds—Broom-corn: Iowa, 30 pounds to the bushel; Dakota, 30 pounds to the bushel.

Cotton: Georgia, 30 pounds to the bushel; Missouri, 33 pounds to the bushel.

Osage orange: Virginia, 34 pounds to the bushel; Michigan, 33 pounds to the bushel; Iowa, 32 pounds to the bushel; Nebraska, 32 pounds to the bushel.

Rape: Wisconsin, 50 pounds to the bushel.

Sorghum: Iowa, 30 pounds to the bushel; Nebraska, 30 pounds to the bushel.

Orchard grass: Virginia, 14 pounds to the bushel; Michigan, 14 pounds to the bushel.

Redtop: Virginia, 12 pounds to the bushel; Michigan, 14 pounds to the bushel.

Sand: Iowa, 130 pounds to the bushel.

E.

Statement showing the population, imports into and exports from the United States, of the various countries of the world, arranged in groups according to the adoption and legalization of the metric system.

Countries.	Population.	Imports, year ended June 30, 1877.	Domestic exports, year ended June 30, 1877.	Foreign exports, year ended June 30, 1877.
OBLIGATORY.				
Argentine Republic.....	1,812,490	\$3,449,559	\$1,129,168	\$97,614
Belgium.....	5,336,634	5,079,149	18,206,025	626,034
Brazil.....	10,108,291	43,498,041	7,499,118	83,695
Chili.....	2,068,424	698,716	2,175,467	52,024
France and French possessions.....	42,100,921	52,862,387	48,526,163	1,591,782
Germany.....	42,723,242	33,035,485	58,192,511	655,303
Greece.....	1,457,894	523,128	190,170	6,458
Italy.....	27,482,174	7,105,366	8,484,496	10,172
Mexico.....	9,276,079	15,444,583	4,509,041	1,389,692
Netherlands.....	3,809,537	2,547,119	10,411,757	156,578
Peru.....	2,730,735	1,545,461	1,239,006	61,546
Portugal.....	4,298,881	594,826	2,361,734	19,030
Roumania.....	5,073,000	560,709	662,261	42,920
San Domingo.....	250,000			

METRIC SYSTEM.

Statement showing the population, imports into and exports from the United States, of the various countries of the world, &c.—Continued.

Countries.	Population.	Imports, year ended June 30, 1877.	Domestic exports, year ended June 30, 1877.	Foreign exports, year ended June 30, 1877.
OBLIGATORY—Continued.				
Spain.....	16,551,647	\$3,220,836	\$10,461,750	\$11,726
Switzerland.....	2,669,147			
United States of Colombia.....	2,910,320	5,454,393	4,022,232	92,167
Uruguay.....	350,000	2,197,711	1,077,434	22,953
Total.....	180,909,415	177,807,469	179,148,333	4,919,754
PARTIALLY IN USE.				
Austria.....	37,700,000	414,020	2,666,246	2,300
Azores, Madeira, and Cape de Verde Islands.....	378,681	92,351	413,637	1,638
Central American States.....	2,577,454	2,833,602	1,304,348	52,338
Denmark.....	1,903,000	9,033	3,329,725	...
Japan.....	33,110,225	13,689,433	2,539,641	385,244
Sweden and Norway.....	6,186,173	243,562	3,041,625	15,144
Turkey in Europe.....	8,500,000	46,714	8,344,522	...
Total.....	90,356,133	17,378,735	21,639,744	456,663
LEGALIZED.				
Great Britain and British possessions.....	237,392,000	165,667,400	437,802,600	14,163,923
Spanish possessions (Cuba, Porto Rico, &c.).....	8,321,000	979,544,185	15,253,358	4,033,651
Total.....	245,773,000	265,211,585	453,055,958	18,197,574
NOT LEGALIZED OR IN USE.				
Danish West Indies.....	37,600	284,480	743,164	8,592
Dutch East Indies.....	24,481,000	4,511,444	2,667,893	...
Dutch West Indies and Dutch Guiana.....		735,525	987,322	18,308
China.....	433,500,000	11,141,447	3,178,594	2,173,290
Greenland.....	9,800	137,465	...	...
Hawaiian Islands.....	56,897	2,631,763	1,296,942	163,530
Hayti.....	572,000	3,303,709	3,851,336	64,664
Liberia*.....	18,000	57,470	122,819	1,861
Russia.....	84,702,980	618,534	4,423,661	769
Turkey in Asia and Africa†.....	33,336,000	382,303	993,979	...
Total.....	576,714,277	23,804,140	18,265,710	2,431,004

* Population of Liberia: Negroes, civilized, 18,000; negroes, indigenous, 700,000. Population of United States in 1870, 38,558,371.

† System lately legalized, see above.

Reply of C. P. Patterson, Superintendent of United States Coast Survey.

UNITED STATES COAST-SURVEY OFFICE,
Washington, March 23, 1878.

SIR: I have the honor to acknowledge the receipt of your communication of the 10th of November, 1877, with which was transmitted a copy of the resolution adopted by the House of Representatives in relation to a proposed change from the standard units of weight and measure, now in common use in the United States, to those of the metric system, and requesting an expression of views from this office.

Frequent consultation with Prof. J. E. Hilgard, the assistant in charge of the Coast-Survey Office and inspector of standard weights and measures, has shown that our views generally coincided in relation to the metric system itself, and also in regard to the general policy to be followed in the endeavor to substitute throughout the country a system of weights and measures entirely foreign to that in common use with us, and which has grown through many generations to be part of our inherited thought. Professor Hilgard having, moreover, had special charge and direction for many years of the details pertaining to our standard weights and measures, I placed the matter of inquiry, which was the subject of the House resolution, in his hands for discussion.

The result is the very able report which I have the honor to inclose herewith, and which I fully indorse, except in regard to the time requisite for effecting the change and making it obligatory in law.

As Professor Hilgard well says, "Our habit is to have our laws follow our customs, and not our customs our laws," the first being from the people and the last from the arbitrary action of irresponsible authority.

To effect the change referred to without shock to the people and great loss to very large investments, it would be necessary, in my opinion, for the law to require that all governmental and State business and returns should be expressed in the terms of both systems—the system now in use and that proposed to be introduced, side by side; that the metric system should be taught in all institutions of learning, both public and private; and that there should be constant agitation and energetic pressure of the new system upon public attention by all persons earnestly interested in the change for a period of not less than thirty-five years.

It is certain that very few adults now living would ever become familiar with the units of the metric system, but would retain the habit of reverting to the *foot*, the *pound*, and our other units, mentally at least, even after the law had disfranchised the old units.

The problem of a change of the kind proposed in a great commercial, agricultural, and manufacturing country like our own is vastly more difficult than it would be in nations the larger portion of the inhabitants of which deal only in a limited manner with small quantities. This subject has been a matter of much thought to myself for several years, and the more I have heard it discussed the more convinced I have become that a matter so grafted into the daily habit and thought of the whole people can only be changed by, as it were, the slowest absorption, and that not less than thirty-five years will be required to effect even a semblance of a change, after the date of the law fixing a time when the new system shall be compulsory.

Some enthusiasts earnestly believe, taking counsel of their own earnestness and hopefulness, that a complete change could be effected throughout the country in, say, from five to ten years; but we have only to remember the length of time it has required for the decimal coinage, the most facile of all standards to change, to obtain universal acceptance and usage in all parts of the United States. In some places, to this day, after a hundred years of trial, we occasionally hear that eight shillings, or six shillings, or four and sixpence "make a dollar;" and only a few years since we heard of "picayunes" and "bits," which respectively were worth 6½ cents and 12½ cents, suggesting the naturalness to the uninstructed mind (a majority in all countries) of the binary system in lieu of the decimals, as the system of *halving* is almost universal. The decimal is, for all scientific computations, indispensable, but it is still an open question which is the best for ordinary use in life, the decimal or the binary—this natural or that artificial system.

I am well aware that the rising generation in this rapid nation of ours, who look forward, think a view of thirty or forty years interminable; but we, who look back, know how sadly short it is. The only hope of a thorough change from our system to the metric system is in the education of, not only the present rising generation, but of that which is to come after a law shall be adopted fixing the date when the new system should be compulsory.

I earnestly recommend that, in a matter so nearly touching all relations of life in this busy nation, no law be passed upon this subject without the most mature deliberation, and that, when passed, it should not have compulsory effect until at least thirty-five years after the date of its passage.

Very respectfully yours,

C. P. PATTERSON,
Superintendent Coast Survey.

HON. JOHN SHERMAN,
Secretary of the Treasury, Washington, D. C.

BUREAU OF WEIGHTS AND MEASURES,
UNITED STATES COAST-SURVEY OFFICE,
Washington, March 21, 1878.

SIR: The answer to the resolution of the House of Representatives relative to the obligatory use of metric measures, referred by you to this office for report, may be conveniently arranged under the following heads:

I. As to the operations of the Coast Survey.

II. As to those of other bureaus of the Treasury Department.

III. As to the people at large.

These will be considered consecutively, and as the last question of the resolution opens the whole subject, it will not be improper to consider its bearing upon some other branch of the public service.

I. In the operations of the Coast Survey the meter is used, and has been employed from the first as the unit of measure. The depths of water or sounding are, nevertheless, expressed in feet and fathoms, in conformity with the immemorial custom of American and British mariners. To have given the depths of channels in the unfamiliar unit of meters would have obviously destroyed the usefulness of the charts and added another element of danger. The object of the charts being that of giving important information in the most available form, not that of diffusing a knowledge of the metric system, the use of feet and fathoms was imperative for the depth of water, and as a matter of consistency the elevations of the land are likewise expressed in feet.

On the Coast-Survey maps, in addition to the natural or metric scale, expressed in a decimal ratio to the natural dimensions, such as $\frac{1}{100000}$, $\frac{1}{200000}$, &c., are given scales of land miles and sea miles, the latter being an angular rather than a linear measure, viz., 1' of arc.

In the printed tables of positions determined by the Coast Survey, the distances are given in meters, yards, and miles.

After these explanations, it will be apparent that the metric system is now used in the Coast Survey to the full extent that is consistent with the usefulness of the form in which the results are given to the people.

The exclusive use of metric units would deprive the charts of much of their usefulness, at least until the metric system had become perfectly familiar to our mariners, and they had accustomed themselves to think of the draught of vessels and to regulate sounding-lines in meters and tenths.

If American charts of American coasts were now issued with depths in meters, the result would be that every one would use the British reproduction of the same, in which the customary units are used.

The only mode of furthering the gradual adoption of the metric units in navigation would seem to be by the publication of the charts in two forms, one giving fathoms and feet, the other meters and tenths, in order that the mariner or pilot may choose those which he prefers.

II. Other bureaus of the Treasury Department in whose operations measures of weight, length, or capacity are seriously involved, are those having charge of *coinage*, *customs*, and of *internal revenue*.

The officers having charge of those important interests have, no doubt, been asked to express their opinions; but the form of reference of the House resolution to this office seems to call for an independent review of the question.

In the matter of coinage there appears to be no serious objection to making the exclusive use of metric weights obligatory. In the inside operations of the mints, they have long been employed in assaying. In the transfer of bullion and coin, troy ounces, with decimal subdivisions, are in customary use. It cannot be said that metric units would be more convenient, since the advantages of a decimal system are already obtained; but they would be equally so, the persons engaged in the work being of great intelligence and readily able to make their statements in either form. Depositors of bullion for coinage or dealers with the mints being beneficiaries, could be reasonably required to conform to any system the government saw fit to adopt.

In the matter of *customs* or *duties on imports*, the question assumes a peculiar form. Importations from nations using metric units are now stated in metrical invoices, while those from non-metric nations, of which the invoices from Great Britain form the larger part, are mainly stated in the customary units of this country, and in conformity with the terms of the tariff.

As the metric units are legal in this country, it would appear to require only an executive order that the duties be levied upon the metric invoices according to the lawful equivalents, without first converting meters into yards, kilograms into pounds, liters into gallons. On the other hand, to require invoices in the customary units to be transformed into metric units, as would be implied by the "obligatory" use of the latter, appears to serve no useful purpose except that of propagating the metric system to the great inconvenience of everybody concerned. The permissive use of two different sets of units in assessing the duties may appear to some minds objectionable as a want of "system," but there is an inherent diversity in the case which has to be met at one point or the other, and which may be illustrated by saying that it is doubtless convenient that some custom-house officers should know the German and French languages as well as the English. Until all nations use the same language and the same money, but little is gained in the way of unification of values by making the units of weight and dimension alike.

In view of the want of simple relations between the customary and the metric units, the department may find it convenient to procure some legislative authority for throwing off certain fractions in the table which would express the duties on metric invoices, on the basis of the legalized equivalent. If such concession to simplicity were made in favor of the metric units, their employment would doubtless be stimulated by such advantage.

Recurring to the question of the House, what inconvenience to the public service would arise from the obligatory use of the metric system in the customs department, the answer is that great inconvenience would arise from the want of familiarity with that system of the officers assessing the duties. It must be borne in mind that the efficiency of such an officer depends in the greatest degree upon his familiarity with the values of goods submitted to his inspection, and that he cannot separate in his mind the expression of measure from that of value. The expression which gives him a check on fraudulent invoices is fixed in his mind in such form as—this quality of silk is worth so much per yard; this tea is worth so much per pound, &c. The transformation into other terms of measure will break away entirely from his habits of thought, and his experience is practically lost.

It is not disputed that other and younger men would gain experience on the new basis, and the question as to the term within which the use of a new system might be made obligatory and exclusive may, from this point of view, be answered, that not less than twelve years should elapse. We should always bear in mind, however, that if any term be fixed it will be necessary to hold out such contingent inducements as to lead the people to adopt that system in their private transactions; otherwise we should find ourselves, at the end of any stated term, confronted by the same state of facts as at present, namely, that the usage of the people does not conform to that proposed by the government.

Moreover, we should bear in mind that in this matter of duties on importations, as in that of taxes on domestic manufactures, the government is the beneficiary, unlike the case of *coinage* before treated of, and that in the latter cases the government practically assumes to be a partner in the transaction, and should not impose conditions onerous to its active partner, the importer or home manufacturer.

In the *Internal Revenue Department* the principal subjects of taxation are tobacco and alcoholic spirits. The value of the former product depends so much upon qualities which are not reducible to weight or measure that it need not be specially considered here, since general considerations applied to spirits will equally apply to tobacco.

A very large proportion of the internal revenue is derived from the imposts upon alcoholic spirits. The questions submitted bear most forcibly upon this branch of the public service, as it is a case where the practice of estimating the values is of no consequence to other nations, it being wholly a matter between the government and the people engaged in the business of converting grain into alcohol.

The government is largely the beneficiary in the transaction. It is not only due to the people that they should not be needlessly compelled to use an unfamiliar way of accounting with the government, but it is greatly to the interest of the latter that in a matter of so vast importance to its revenue the experience of its officers should not be lost. An experienced ranger, to give an illustration, has a check on his measures and calculations by familiarity with sizes of casks, the contents, in *gallons*, of which he can estimate very nearly; but if required to express them in *liters*, this experience would wholly fail; and it is safe to say that such familiarity with the metric measures would never be acquired by the same persons.

The objection, then, to making the use of the metric measures obligatory in this part of the public service is that the liability to error would be greatly increased, and that the manufacturer and dealer would lose the advantage they now have, and which is fairly due them, of having the taxed value of the product expressed in quantities that are customary used in their trade.

On the other hand, the advantages to be derived from the use of metric measures are, in this instance, hardly assignable.

The statistics of this and other branches of the public service would doubtless be more universally available if they were expressed in both the customary and the metric units. This can be readily effected by converting aggregates, without imposing the use of metric measures in every single transaction.

The general answer to the question of how long a preliminary notice should be given before the obligatory use can be introduced without detriment to the public service, necessarily depends largely upon the estimate of the time that must elapse before the people become practically acquainted with the new system. So far as the matter of the collection of taxes upon spirits is concerned, it is the opinion of this office that it should not be enforced before 1890, in order to give time for the instruction now given in public schools to reach a large number of officers and persons engaged in the business.

III. In attempting to form an opinion upon the question, "What objections there are, if any, to make the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for its obligatory use throughout the United States?" the following considerations present themselves:

1. That the adoption of the metric system by the people of the United States would be an advantage is taken for granted by the House resolution. Admitting this assumption, it is useful to state here the grounds upon which it rests. These are two-

fold, namely, inherent convenience and probable universality. The first point is sustained by its conformity to the universal system of decimal arithmetic, and the direct relations between measures of length, volume, and weight. The second is asserted on the basis that the metric system has been adopted by nations whose population far outnumbers that of those nations with whom the Anglo-Saxon units are customary.

A careful review of the logical and historical facts in the premises leads this office to the opinion that if any universal system of weights and measures is to obtain, the metric system is the one that has at present the greatest probability of supplanting all others. Before its adoption by the German and Austrian Empires, within the last six years, this probability was by no means very decided; for many of the millions of people counted as having the metric system in use were in fact not using any measures at all, being herders and peasants, while among the non-metric nations manufactures and commerce were flourishing. The United States, Great Britain, and Russia having identically the same units of length and weight, while those of Germany and Austria were nearly the same and called by the same names, it appeared not at all improbable that in unifying their local diversities the latter states would also adopt the Anglo-Saxon units. Since they have, however, adopted the metric units and made their use compulsory, we may consider the changes turned in favor of the latter, and may assume that if the Government of the United States would promote general uniformity, it must do so by furthering its actual adoption by the people in their private transactions.

The legalization of the use of metric units, in 1866, was the first step toward that end. The next should be the enactment of laws requiring their use in such government transactions as will not suffer by the sudden change of the habits of men. There, perhaps, legislation must stop for a long while, until by zealous inculcation, by agitation, by instruction in all public schools, the new system shall have been voluntarily adopted by a great majority of the people, when the enactment of an obligatory law will only be the consummation of an existing state of facts.

It has ever been the practice of the Anglo-Saxon people to make laws in conformity with customs, not to create customs by compulsory laws.

It is indeed difficult to see how an obligatory statute could be executed in this country. We would hardly undertake to suppress the use of the inch, pound, and gallon by penalties, as has been done under the parentally despotic governments of Europe, where, as in Prussia, fine and imprisonment followed the possession of the old standards. It may even be considered doubtful whether the legal mind of the country would approve a statute decreeing that only contracts made in terms of the new standards could be enforced by the courts, since it would violate the principle that any agreement made in good faith can be maintained at law, a principle far more important than conformity in weights and measures with other nations. In attempting answer to the last question propounded by the House resolution, we therefore consider it to imply: How long is it likely to be before the metric system will come into so general use among our people that no hardship will be felt from making it obligatory?

If left to itself its growth would be very slow, and the period necessary might be reasonably estimated at not less than fifty years. The fixing of a time in advance, say the year 1900, would materially aid its growth, and an active propaganda by the friends of the measure, like that initiated by the American Metric Bureau of Boston, would greatly accelerate its general adoption. In view of the very marked effect of the endeavors of that organization, this office would give its opinion that the year 1900 might now be fixed as the time when the use of the metric system should become obligatory throughout the United States. Should our anticipations be deceived such a statute would doubtless be repealed before the time had arrived.

The difficulties attending the adoption of a new system of weights and measures are far greater than is generally thought. The matter presents itself on the surface as a question of preference, involving little more than the mental acquisition of certain terms and their relative values, and the surrender of certain acquired habits. A century ago this would have been a fair statement of the case. At the present time very large pecuniary interests are involved in any change, and oppose it. The work of the world was then done by hand with simple tools, and the only change involved was the use of a metric rule in place of a foot rule. Now that work is mainly done by machinery, the value of which depends in a great degree on the units of measure to which it is constructed, and a great part of it becomes obsolete when those units are changed. The great machine shops devoted to building machine-tools for the construction of machinery used in the various industries, alone represent values of many millions of dollars, and much of their present "plant" would have to be thrown away and replaced by new, in order to adapt their products to metric units.

Assuming that there were the heartiest common consent to use metric measures in all new machinery, how difficult and long would be the transition? The new things would not fit in the old places. A very large proportion of the work is in supplying worn parts; where, then, are the dimensions to come in? The immense plant of railway motive-power in the United States is all made to inches and decimals; at what

time can a railway company afford to change the dimensions of the parts of a locomotive engine? At no time, it would answer, because the change would require to be simultaneous in the whole stock. It is true that the old dimensions might be adhered to, but called by metric names, putting 0.0254 meter or 25.4 millimeters for one inch, but this would only be an evasion, not a solution of the problem.

The foregoing considerations have been forcibly presented in a communication from our government to other nations, printed in the report on Foreign Relations for 1870, pp. 240-247, in connection with a proposition for assimilating international coinage. In that paper an important reference is made to the terms in which "real estate" is defined in this country. Not only are lands purchased from the public domain described in a simple decimal system of acres measured by square chains and decimals, but all the most valuable real estate, such as lots and streets in cities, has been laid off in this country in even feet, generally even tens of feet, as 50, 60, 80, 100, 150, &c. What adequate motive is there to change these expressions into terms which are necessarily fractional, and in which those foreign nations whose convenience it is proposed to meet have no conceivable interest? What useful purpose is subserved by designating a building lot 24 by 120 feet in the form of 7.315 by 36.576 meters?

It is the foregoing and similar considerations which lead the undersigned to doubt whether the international units of measure will ever wholly take the place of all others in our domestic transactions.

All of which is respectfully submitted.

J. E. HILGARD,

Assistant United States Coast Survey, and
Inspector United States Standard Weights and Measures.

C. P. PATTERSON,
Superintendent United States Coast Survey.

Reply of E. B. Elliott, chief clerk Bureau of Statistics.

TREASURY DEPARTMENT, November 20, 1877.

SIR: In response to the departmental letter of the 10th instant, desiring me to transmit to the department, as early as possible, my views upon the several questions submitted in an accompanying resolution of the House of Representatives, in which resolution the heads of the executive departments were requested to report to the House what objections there are, if any, to making the metrical system of weights and measures obligatory in all governmental transactions, and how long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service, and also what objections there are, if any, to making the metrical system obligatory in all transactions between individuals, and what is the earliest date that can be set for the obligatory use of that system throughout the United States, I have the honor to state that it seems to me desirable that the metric system of weights and measures be made obligatory in certain governmental transactions, chiefly in those of an international character, such as for postal purposes, for the purposes of coinage, and for the assessment of customs-duties.

The metric system for such governmental purposes may, I think, go into operation without detriment to the public service with the fiscal year commencing July 1, 1879.

It would be well that a tariff schedule of the common and metric equivalents be prepared prior to the full application of the system for customs purposes.

I do not consider it advisable to make the use of the metric system immediately obligatory in transactions pertaining to the transfer of lands, to the collection of internal-revenue dues, or to the internal transactions of the government generally, the changes involved thereby being so numerous and seemingly difficult as possibly to elicit strong protest from many persons engaged in the active pursuits of life with whom the government would have business transactions, and whose immediate interests might for a time be unfavorably affected. Nor do I think it advisable to make the metric system obligatory in the near future in transactions between individuals in the business of private life. Its use is now, by law, permissive between individuals. It may, however, be advisable to render the use of the system obligatory upon the more extended lines of rail and water communications of the country in their operations in regard to freight.

It seems to me advisable that the rendering the use of the metric system obligatory for local and domestic purposes be left, for the present at least, for the action of State Legislatures.

I append tables A and B, showing equivalents of the units of the metric and the ordinary systems applicable for customs purposes.

I also append to this communication a copy of the second and third reports, and an extract from the fifth report, of the British standards commission—the astronomer royal, George B. Airy, chairman. (See Appendices C, D, and E.)

The second of these reports bears more particularly on the introduction into the country of the metric system of weights and measures, and resulted in several practical recommendations "having for their object the permissive use of the metric system in the United Kingdom, more especially for international purposes."

The third report recommends the abolition of the troy weight, and that the imperial (avoirdupois) and the metric weights be alone authorized to be used. The permissive use of the metric system of weights and measures has been for several years legalized in Great Britain.

The difficulties, if any, which may be apprehended in the substitution of the thoroughly correlated metric system in the international transactions of the government seem to me more imaginary than real, while the advantages to be derived from the introduction for such international purposes of a system which has no rival in respect to simplicity cannot be successfully questioned.

Respectfully,

E. B. ELLIOTT.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

A.—Table for converting certain rates of duty expressed according to units of the ordinary system of weights and measures into their metric equivalents.

\$1 per inch.....	=\$3.93 70	per decimeter.
1 per foot.....	= 3.28 09	per meter.
1 per yard.....	= 1.09 36	per meter.
1 per square inch.....	= 0.15 50	per square centimeter.
1 per square foot.....	= 0.10 764	per square decimeter.
1 per square yard.....	= 1.19 60	per square meter.
1 per cubic inch.....	= 0.06 1025	per cubic centimeter.
1 per cubic foot.....	= 0.03 531	per cubic decimeter.
1 per cubic yard.....	= 1.30 898	per cubic meter.
1 per fluid-ounce.....	= 3.38 134	per deciliter.
1 per pint.....	= 2.11 336	per liter.
1 per gallon.....	= 0.26 417	per liter.
1 per proof-gallon.....	= 0.26 417	per proof-liter.
1 per quart (dry measure).....	= 0.90 8	per liter.
1 per bushel (dry measure).....	= 2.41 875	per hectoliter.
1 per bushel (32 lbs. avoirdupois).....	= 6.89 0	per quintal (100 kilos).
1 per bushel (56 lbs. avoirdupois).....	= 3.93 7	per quintal.
1 per bushel (80 lbs. avoirdupois).....	= 2.75 6	per gram.
1 per grain.....	= 15.43 2	per decagram.
1 per ounce troy (480 grains).....	= 0.32 12	per decagram.
1 per ounce avoirdupois (437.5 grains).....	= 0.35 27	per kilogram.
1 per pound troy (5,760 grains).....	= 2.67 02	per kilogram.
1 per pound avoirdupois (7,000 grains).....	= 2.20 46	per quintal.
1 per hundred-weight (112 lbs. avoirdupois).....	= 1.96 84	per quintal.
1 per cental (100 lbs. avoirdupois).....	= 2.20 46	per millier or metric ton.
1 per ton of 2,000 lbs. avoirdupois.....	= 1.10 23	per millier or metric ton.
1 per ton of 2,240 lbs. avoirdupois.....	= 0.98 42	per millier or metric ton, or 1,000 kilograms.
1 per ton of 28 bushels of 80 lbs. avoirdupois	= 0.98 42	

EXAMPLES, ILLUSTRATIVE.

Customs duties:

Alcohol: \$2 per proof-gallon (or 53 cents per proof liter).
 Ale, beer, and porter, in bottles: 35 cents per gallon (or 9 $\frac{1}{2}$ cents per liter).
 Acetate of ammonia: 25 cents per pound (or 55 cents per kilogram).
 Candles, tallow: 2 $\frac{1}{2}$ cents per pound (or 5 $\frac{1}{2}$ cents per kilogram).
 Carpets, Brussels: 44 cents per square yard (or 52 $\frac{3}{10}$ cents per square meter), and 35 per centum ad valorem.
 Hats, of wool, not exceeding 40 cents per pound (or 88 cents per kilogram): 20 cents per pound (or 44 cents per kilogram), and 35 per centum ad valorem.
 above 40 cents per pound (or 88 cents per kilogram), and not exceeding 60 cents per pound (or \$1.32 per kilogram): 30 cents per pound (or 66 cents per kilogram), and 35 per centum ad valorem.
 Pig-iron: \$7 per ton (or \$6.88 per metric ton or millier).

B.—Table of existing rates of duty on glass, expressed in metric units.

Greatest dimensions in square decimeters.	Contents in square decimeters.	Descriptions of glass and rates of duty.					
		Fluted, rolled, or rough plate, per square decimeter.	Unpolished cylinder and common window, per kilogram.	Polished cylinder and crown, per square decimeter.	Cast polished plates, unsilvered, per square decimeter.	Silvered looking-glass plates, per square decimeter.	
1	2	3	4	5	6	7	
2.540 (10 inches) by 3.810 (15 inches).....	9.678	Mills.	Cents.	Mills.	Mills.	Mills.	
4.064 (16 inches) by 6.096 (24 inches).....	24.774	1 $\frac{1}{4}$	3 2 $\frac{1}{2}$	4	4	3	4
6.096 (24 inches) by 7.630 (30 inches).....	46.452	1 $\frac{1}{2}$	5	6	5	6	6
All over.....	All over.....	All over.....	6	6	5	8	10
6.096 (24 inches) by 15.240 (60 inches).....	92.903	2	20	25	25	35	
All over.....	.....	.....	40	50	50	60	

To the foregoing rates of duty add, in column 4, one-tenth, and in columns 3, 5, 6, and 7, three fortieths of such rates.

N. B.—All fluted, rolled, or rough plate-glass weighing over 100 pounds per square foot (or 4.9 kilograms per square decimeter), must pay an additional duty on the excess at the same rates as above, and on looking-glass plates or plate-glass silvered, when framed, there is a duty of 30 per cent. ad valorem on the frames in addition to the above rates.

C.—Standard commission.

SECOND REPORT.

To the Queen's Most Excellent Majesty:

May it please Your Majesty: We, the commissioners appointed under Your Majesty's royal warrant dated the 4th day of May, 1863, for inquiry into the condition of the exchequer standards (now called the board of trade standards or the official standards) of length and weight, and for other purposes therein set forth, acting under the directions to us contained in the said warrant, to report to Your Majesty from time to time the result of our inquiries, humbly offer to Your Majesty our second report.

1. In closing their first report, submitted to Your Majesty under date of 24th July, 1863, the commission adverted to the metric system, and especially to the probable effect of attempting to introduce it into this country. This subject appeared to enter legitimately into their consideration, inasmuch as the introduction of a new system would imply addition to the existing board of trade standards, to which (among other things) the inquiries of the commission are by Your Majesty's royal warrant specially directed, and the commission expressed their sense of the great importance of the question, and undertook to give to it their early and careful attention.

2. In their desire to redeem this pledge the commission have thought it advantageous to confine themselves in this their second report to the questions connected with the metric system, deferring to a later report all allusion to the various points connected with the proceedings of the standards office, and with the British law and its administration relating to the imperial system of weights and measures.

3. It appears to the commission that the reasons which may be urged for or against the introduction of a new system will naturally arrange themselves under two heads, namely, those which relate to the internal commercial transactions of the country, and those which relate to transactions with other countries. It is proposed here to consider the subject in that order.

4. With reference to the question as bearing upon internal commerce, the commission have thought it desirable to examine into the reasons assigned for changes of system in other countries, and, if possible, to ascertain the results of their experience; and to inquire whether similar reasons apply, and what may be anticipated as the effect of change in this country.

5. As regards the first of these trains of inquiry, the commission have derived most valuable information from official papers of other countries, transmitted either directly or through the board of trade to the warden of the standards, and by him communicated to the commission. The information thus laid before them is appended to the report. Among these documents the most important are those of France, the United States of North America, North Germany, Switzerland, and India. As regards the second inquiry, the commission have had before them the evidence collected by preceding standards commissions, and especially that which was heard by a committee of the House of Commons in the year 1862; they have also had the results of their own personal experience, both in matters of science and in transactions of daily life.

6. The commission remark that in the statements introductory to the proposals for new systems in France, North Germany, and India, very great stress is laid upon the discordance in the fundamental units of their customary weights and measures, as adopted in different districts of the same empire. These reasons have no force in Great Britain and Ireland, throughout which, whatever difference may prevail as to the multiples in local use, the fundamental units, namely, the yard, the pound, the gallon, are strictly the same—based upon national standards which are constructed with the utmost skill and care, and supported by a system of inspection which, though chargeable with imperfections (to which the commission at present advert no further), is, on the whole, efficient. The commission also remark that, in the introduction of the new system into Switzerland, it appears to have been rather the object of the proposers to define accurately the relation of their standard to the French standard than to adopt the metric system; thus the Swiss foot is defined to be three-tenths of the meter (*sic*), a proportion which seems to be irreconcilable with the practical adoption of a decimal scale.

7. On the results of the introduction of the metric system, as matter of experience, it is difficult to give a certain statement. The great mass of people in France undoubtedly adopt it, both in the names and in the values of the weights, measures, and coins; although such names as the *livre* and the *sou*, for the half kilogram, and the piece of five centimes, are still in common use. In Holland and other neighboring countries the metric system, though very generally adopted, is, it is believed, still less perfectly introduced.

8. In the United Kingdom, so far as can be conjectured, the existing imperial system has, in its main features, grown up spontaneously among the people, and the action of the legislature has been limited to such practical measures as the following: the giving of certainty and precision to the fundamental standards; the establishment of accurate and more simple relations among systems which at first probably had no connection (as those of the stone and the pound), and, in some instances, the abolition of measures, &c., which, while bearing the same name, had slightly different values (as the various gallons). If this conjecture be correct, it tends to prove that the existing system meets the popular wants, and that it will not easily be expelled from popular use.

9. There is good reason to believe that in large factories a decimal division is frequently convenient, and in many cases, for commercial reasons, the most convenient base for that division is the metric. The owners of those factories can, however, arrange such matters, to a great extent, without legislative assistance. But for sales in shops, which specially require the care of the legislature, and for ordinary work, other considerations apply. Different bases must be adopted; for instance, the yard is a very convenient length for drapers' measure, but the foot is far more convenient for carpenters' measure. It has been remarked that the last or comb, the bushel, and the peck are well suited for men's backs, arms, and hands. The natural inclination of the mind to halve and quarter continually exhibits itself in the subdivision of almost every base; thus in avoirdupois weights and in measures of capacity the progressive halving of the pound and bushel, and their lower denominations, is continued nine times, and the binary subdivision extends to $\frac{1}{12}$. The metric system does not offer the same facility either for change of the adopted base or for the continued binary subdivision; and any attempt to force it into use in shops, and into workmen's operations and their accounts, would probably be felt as a needless grievance.

10. The commission are obliged to remark here that the evidence as to the feeling of the great class of vendors in shops and ordinary tradesmen is rather of an inferential than of a positive character. Among the witnesses examined by the committee of the House of Commons which sat in 1862, there is not one shopkeeper, and scarcely one person of the lower working class. The evidence collected by the preceding standards commissions cannot fairly be cited now, as the question of introducing the metric system into this kingdom had then hardly been raised. But the commission cannot omit to call attention to the distinct though negative fact that not a single movement has been made on the part of shopkeepers or workmen for procuring a change, and not a single complaint has been made by them of the existing legal system of imperial weights and measures.

11. It is obvious that in this country, where the people are more accustomed to self-

government than in other European countries, the executive has far less power of compelling obedience to the law in all the small transactions of trade against the wishes of the public. Should an attempt be made at the present time to introduce the metric system by legal compulsion, the commission regard it as certain that very great confusion would be produced, and they think it highly probable that the attempt would be met by such an amount of resistance, active and passive, that it would totally fail.

12. At the same time the commission remark that the want of weights and measures on a decimal scale generally, or on the metric scale specifically, is not unfrequently felt by the manufacturing and trading classes, and more especially by men of science and by chemists and engineers of the highest class; and that it appears scarcely possible to satisfy this want, and to place the metric system on the footing which it seems justly to claim, except by the legal establishment of metric standards and of inspectors' standards (where required), and by the legal sanction of the use of metric weights and measures in shops and in offices of conveyance. But such permission, unless very carefully guarded, would lead to the most intolerable and enduring confusion, and the commission expressly state their opinion that any enactment giving permission to use metric weights and measures for public sales and conveyance must be accompanied with such provisions for their form or other characteristics as will make it impossible to mistake them for weights and measures of the existing imperial system. With very careful attention to these provisions, the commission see no objection to the permissive introduction of weights and measures on the metric system into shops and offices of conveyance, provision being also made for inspectors' standards and powers of inspection where required.

13. With the view of further lessening any confusion that might be occasioned by the addition of a new series of weights to those now existing of the avoirdupois and troy scales, the commission have had under their consideration the question of the discontinuance of troy weight. They refer to the opinions expressed by the standards commissions of 1841 and 1854, in favor of the simplification of the British system of weights by the abolition of the troy scale. Apothecaries' weight, based on troy weight, has since been legally discontinued under the authority of the medical act, 1858, and avoirdupois weights have been substituted in the dispensing of medicines. Much of the difficulty of the discontinuance of troy weight is thus removed, its use being now limited to manufacturers of and dealers in gold and silver wares and bullion. Still these form a numerous class, and the commission feel that they cannot make any definite recommendation for abolishing troy weight without having first inquired extensively into the practice and feelings of persons who now use that system. The assay of the precious metals, the ascertaining the standard of gold and silver, the operations of coinage, and the levying the duty on gold and silver plate, all are now based by statute on troy weight; and in the event of its abolition, it will become necessary to make further provision by law for the weights to be used for these purposes. It may also be a matter deserving consideration how far it may be expedient to substitute metric weights. The commission will give their careful attention to these points, and the results of their labors must be deferred to a future report.

14. Passing now to the consideration of our transactions with foreign countries, the commission express their full belief that the foreign commerce of this country, especially with France and with other countries which have introduced or proposed to introduce the metric system, has in late years increased much more rapidly than the home trade, though in what proportion it is difficult to ascertain. But, great as that foreign commerce undoubtedly has become, it is small in comparison with the home trade. From the report of the Postmaster-General in the year 1864, it appears that the number of foreign letters (requiring apparently to be doubled for proper comparison of the number of transactions) was about one-fiftieth of the number of home letters. If we refer to the accessible returns relating to money transactions, the amount of stamp-duty levied on foreign bill stamps, about £350,000 annually, implies foreign transactions to the amount of £600,000,000; while the amount of checks and bills passed at the London Clearing House (in which many of the London bankers take no part) is about £3,300,000,000, and the transactions in the manufacturing districts and the interior of the country generally multiply this in an unknown ratio. Still, the existence of this large foreign trade is an argument for the permissive adoption of the metric system which agrees with that of so many of our foreign-trade correspondents; and great advantage will evidently be introduced, unaccompanied (so far as can be remarked) with any bad effects, by giving the ordinary statistical publications relating to foreign trade, and in some instances to home trade also, on the metric as well as on the imperial system.

15. As bearing upon all parts of this inquiry, the commission think it their duty to call attention to the advantage of establishing in this country a decimal system of coinage. The decimal division gives the greatest facilities for the gradation of prices, and for the great number of additions, multiplications, and divisions continually presenting themselves in money affairs, but more rarely occurring in the combination of the several de-

nominations of weights and measures, and the commission think it probable that extensive familiarity with decimal coinage would materially tend to facilitate the introduction of a decimal scale of weights and measures where it can be useful. The commission do not disguise their apprehension that a change of coinage would produce for a time some confusion. At the same time they observe that it is absolutely in the power of the government to effect the change without any risk that the resistance which might be made by those who preferred the old system could ultimately prevail against it.

16. Guided by the preceding considerations, the commission have unanimously agreed upon the following resolutions:

(1.) Considering the information which has been laid before the commission: of the great increase during late years of international communications, especially in relation to trade and commerce; of the general adoption of the metric system of weights and measures in many countries, both in Europe and other parts of the world, and more recently in the North German Confederation and in the United States of America; of the progress of public opinion in this country in favor of the metric system as a uniform international system of weights and measures; and of the increasing use of the metric system in scientific researches, and in the practice of accurate chemistry and engineering construction, we are of opinion that the time has now arrived when the law should provide, and facilities be afforded by the government, for the introduction and use of metric weights and measures in the United Kingdom.

That for this object metric standards, accurately verified in relation to the primary metric standards at Paris, and deposited in the standards department of the board of trade, should be legalized; and that verified copies of the official metric standards should be provided by the local authorities for inspectors of such districts as may require them.

(2.) Considering the advantages of adopting in an international system not only of uniform weights and measures, but also uniform names, and that although there may be well-founded objections to the inconvenient length and occasional similarity, both to the eye and ear, of the French nomenclature, yet it is probable that these names will become familiar by custom, and obtain popular abbreviations.

We think that the French nomenclature, as well as decimal scale of the metric system, should be introduced in this country.

(3.) Considering that there is no immediate cause requiring a general change in the existing system of legal weights and measures of the country for the purposes of internal trade; that the statutable values of the fundamental imperial units are adopted in use without the slightest variation throughout the whole of the British Isles; that the primary imperial standards are as perfect as can be made by modern skill and science, and that the whole series of official standards are now most accurately verified in relation to the primary standards; that a very large number of copies of the official imperial standards, accurately verified, are now in use by the local inspectors of weights and measures; that it is estimated there are nearly thirty millions of ordinary weights and measures of the existing imperial system now in common use; that at the present time there is no evidence to show that any considerable portion of traders and their customers in this country are dissatisfied with the imperial system now in use, or that they desire to substitute the metric system for it, we are of opinion that the general introduction of the metric system should be permissible only, and not made compulsory by law after any period to be now specified, so far as relates to the use of metric weights and measures for weighing and measuring goods for sale or conveyance.

(4.) Considering that during the concurrent use of the metric and imperial systems it will be expedient to prevent as far as possible imperial and metric weights and measures from being accidentally or fraudulently substituted for each other, we are of opinion that authoritative regulations should be established, under which each series may be readily and easily distinguished, by the adoption of conspicuous distinctive forms or marks for the several weights and measures, and by such mode as may be determined upon after due inquiry.

(5.) We are of opinion that it is expedient that customs duties should be allowed to be levied by metric weight and measure, as well as by imperial weight and measure; that the use of the metric system concurrently with the imperial system should be adopted by other public departments, especially the post office, and in the publication of the principal results of the statistics of the board of trade, as well as for the admeasurement and registration of the tonnage of shipping.

(6.) And that mural standards of the metric system, as well as of the imperial system, be exhibited in public places.

(7.) Considering that the metric system, as adopted in other countries, includes the relation of coinage to weights and measures, particularly in its uniform decimal scale, and that the advantages of the introduction of the metric system into this country as an international system of weights and measures would be much increased by establishing a corresponding international system of coinage, in regard to a unit and to a deci-

mal scale, we are of opinion that, even if the difficulty of establishing an international unit of coinage cannot be at present overcome, yet the decimalization of our system of coinage, which is in the power of the government, would be very useful to the public.

(8.) Considering the great national importance of the question of the introduction of the metric system of weights and measures into this country, it appears to us essential that any measure for this object should be proposed to Parliament by the executive government.

(9.) Considering that the commission will very shortly enter upon the questions referred to them relating to the system of local inspection of weights and measures throughout the United Kingdom, we are of opinion that it is expedient that no legislation should take place with respect to the metric system until the whole subject of the weights and measures of this kingdom be brought before Parliament in one bill.

All which we humbly submit to Your Majesty.

G. B. AIRY, *Chairman.*
COLCHESTER.

STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
THOMAS GRAHAM.
W. H. MILLER.
H. W. CHISHOLM.

7 OLD PALACE YARD,
April 3, 1869.

D.—Standards commission.

THIRD REPORT.

The Queen's Most Excellent Majesty:

We, the commissioners acting under Your Majesty's royal warrant dated 4th May, 1863, for inquiry into the condition of the exchequer standards (now called the board of trade standards or the official standards) of length and weight, and for other purposes therein set forth, in pursuance of Your Majesty's commands to report to Your Majesty from time to time our several proceedings by virtue of the said commission, humbly offer to Your Majesty our third report.

1. Among the duties intrusted to us by Your Majesty, we have been directed to inquire and to report whether any and what additions to the existing board of trade standards are now required, and if any and what existing standards should be discontinued and cease to be secondary standards. In our second report, dated 3d April, 1869 (S. 13), we submitted to Your Majesty that we had under consideration the question of the discontinuance of troy weight, and how far it may be expedient to substitute metric weights; and that after we should have inquired extensively into the practice and feelings of persons who now use the troy system, we proposed to state the result of our labors in a future report.

2. In the papers appended to this report will be found all the information accordingly laid before us upon the subject, including the evidence of several witnesses selected by us as fairly representing the classes of persons whose interests were deemed to be involved in the continuance or abolition of troy weight.

3. After mature consideration we have come unhesitatingly to the conclusion that it will be for the public advantage to simplify the imperial system of weights by legislative provisions for the abolition of troy weight.

4. There appears to be no trustworthy record of the origin of the troy system, the abolition of which is now recommended. The troy pound is said to have been derived from the Roman weight of 5739.2 grains, the 125th part of the large Alexandrian talent; this weight, like the troy pound, having been divided by the Romans into twelve ounces. The earliest statute of this kingdom in which troy weight is named is the 2 Henry V, st. 2, c. 4, for preventing an excessive charge for gilding silver wares, in which it is enacted that all the goldsmiths of England shall gild no silver worse than that of the alloy of the English sterling, and that they shall take for a pound of troy gilt ("pur la libre de troy orre") but 40s. 8d. at most. But troy weight is universally allowed to have been in general use from the time of King Edward I. The most ancient system of weights in this kingdom was that of the Moneyer's pound, or the money pound of the Anglo-Saxons, which was continued in use for some centuries after the conquest, being then known as the tower pound, or sometimes the goldsmith's pound. It contained twelve ounces of 450 grains each, or 5,400 grains, and this weight of silver coins was a pound sterling. The tower pound was abolished in 1327 by a statute of Henry VIII, which first established troy weight as the only legal weight for gold and silver. This statute was as follows: "And whereas, heretofore,

the Merchant paid for coynage of every Pounde Towre of fyne gold, weighing XI oz. quarter Troye iis. vid.: Nowe it is determined by the King's Highness and his Councill that the aforesaid Pound Towre shall be no more used and occupied, but al maner of golde and sylver shall be wayed by the Pounde Troye, which maketh xii oz. Troye, which exceedeth the Pounde Towre in weight iii quarters of the oz." From this time to the present our system of coynage has been based on troy weight.

5. The reasons upon which we have come to the determination that troy weights should now be abolished by law and other weights substituted will be found in the following resolutions, which have been unanimously passed by us:

(1.) Considering—

That in the report of the standard commission of 1841 and 1854 opinions have been expressed in favor of the simplification of the imperial system of weights by the abolition of troy weight;

That troy weight has since been legally discontinued for pharmaceutical purposes, and avoirdupois weight substituted under the provisions of the medical act, 1864;

That troy weights are now used only for the precious metals and for trade purposes by manufacturers and dealers in gold and silver wares;

That the troy weights so used for trade purposes appear to be the old nest set of ounce weights, increasing in a binary series up to two hundred and fifty-six ounces, according to the old standards established by Queen Elizabeth in 1588, which ceased to be the legal standards in 1824; and that the existing legal denominations of troy weights, as represented by the official standards, are not generally used;

That the decimal series of troy ounces for bullion, legalized in 1853, has never been adopted by the general public;

That it has been shown to us that throughout the United Kingdom only eight counties and thirteen cities and towns are furnished with legal copies of the official troy standards, and two counties and five cities and towns with legal copies of the official decimal bullion standards;

That the legal provisions for stamping and inspecting troy weights throughout the country have been practically inoperative;

That the legalization of the use of metric weights has been recommended by us in our second report, and the concurrent use of three distinct systems of weights will be inexpedient, and tend to produce confusion and complication, more especially as regards the local inspection of weights and measures, as, in the event of the continuance of the troy system, it would be requisite to provide for an equally vigilant inspection of troy weights as of other weights;

That we have satisfied ourselves, from the evidence of various classes of persons now using troy weight in business transactions, that there are no sufficiently valid reasons for the continuance of troy weight which can be placed against the great advantage to the public of simplifying our system of weights by its abolition:

We are of opinion that it is expedient that the use of troy weights be abolished by law.

(2.) We therefore recommend that legislative provision be made that from and after twelve months from the passing of an act for that purpose—

The provisions of the act 5 Geo. IV, c. 74, for ascertaining and establishing uniformity of weights and measures, and of 16 Vict., c. 29, for regulating the weights used in sales of bullion, and of any other act or acts legalizing or requiring the use of troy weights, so far as they relate to the same, shall be repealed.

All secondary standards of troy weight now deposited in the standards department of the board of trade shall cease to be legal secondary standards.

All copies of such secondary standards of troy weight, verified for the use of local inspectors of weights and measures, shall cease to be legal standards.

The use of all troy weights in shops and places where goods are exposed or kept for sale, shall be illegal; and all troy weights found there shall be liable to be seized and forfeited, and the person in whose possession they are found shall, on conviction, be liable to a penalty not exceeding £5.

All contracts for buying and selling made in terms of troy weight shall be void.

Such provisions to apply to all weights and measures used for pharmaceutical purposes; and that it be expressly declared that the powers of regulating the weights and measures to be used in pharmacy, granted to the general medical council under the medical act, 1858, be limited to legal denominations of weights and measures for which standards are provided by law.

(3.) We recommend that for a period of ten years after the passing of the act the use of troy weights for the internal operations of manufactures and workshops, not subject to the visits of inspectors of weights and measures, be permitted, and that no contract or agreement between a master and workmen, or between a wholesale and retail dealer, be illegal in consequence of its being made in reference to troy weight.

But that after the expiration of ten years from the passing of the act the same provisions shall be applicable to such troy weights as to those specified in section 2.

(4.) Considering—

That the several operations connected with the gold and silver coinage, the purchase of bullion, and the assay of the precious metals are frequently carried on with relation to business transactions with foreign countries, and, as such, are matters of international trade;

That we have had the evidence of the late master of the mint that the substitution of the metric system of weights for the troy system, and of the decimal system of assay for the grain and carat system, would be attended not only with no difficulty as regards the mint, the Bank of England, and the bullion trade, but with advantage to the public;

That from the evidence produced before us we have reason to believe that no valid objections or practical difficulties exist to such substitution;

We recommend that legislative provision be made that, in all cases where specified weights of the troy system are recited in any existing act of Parliament, and relate to the weight or fineness of the gold or silver coinage or of bullion, the nearest equivalent metric weights, according to a table of equivalents to be contained in a schedule annexed to the act, be substituted.

And we also recommend that in all statements of assays of gold and silver bullion upon which any legal contracts can be based, the millesimal or centessimal system of assay be substituted for the grain and carat system.

(5.) With regard to troy weights specified in statutes relating to duties on gold and silver plate and on licenses for dealers in gold and silver plate—

We think that it may be sufficient that due legislative provision be made to enable the inland revenue department to substitute either avoirdupois or metric equivalents, or the nearest integral equivalents that may be deemed expedient, until such time as a legislative change may be made in the amounts of these duties for fiscal objects.

In the assessment of customs-duties on gold and silver plate imported into this kingdom from other countries, we recommend the substitution of similar equivalents of metric weight.

(6.) As to the weights to be substituted for those of the troy system now used by the general public and for purposes of manufacture and trade;

Considering—

That we have stated our opinion in our second report that the general introduction of the metric system should be permissive only, and not made compulsory by law, after any period to be now specified, so far as relates to the use of metric weights for weighing goods for sale or conveyance; and that authoritative regulations should be established by which each series of weights may be readily and easily distinguished by the adoption of conspicuous distinctive forms or otherwise;

That it will be a sufficient hardship upon those persons who now use troy weights to be compelled to give them up, although for the general advantage of the public; and it will be manifestly unjust, also, to compel them to substitute metric weights while all other classes of the community are under no obligation to abandon their avoirdupois weights and are allowed the option of using metric weights;

That the grain and its multiples and parts, formerly weights of the troy system, were made avoirdupois weights by the provisions of section 3 and 4 of the act of 1853, for legalizing the restored standards of weights and measures, and will in future be legal weights of the avoirdupois scale only;

That a decimal series of grain weights has been recommended in our first report to be legalized as official standards; and such series from 0.01 grain to 1,000 grains, and additional weights of 2,000 and 4,000 grains, have been constructed and have been most accurately verified in the standards department in order to serve as legal standards and for verifying copies for the use of local inspectors of weights and measures, in order that the public may be supplied with weights of this description duly correct:

It appears to us that upon the abolition of troy weight, all those persons who now use it, either for manufacturing, trading, or other purposes, should be permitted to substitute either avoirdupois or metric weights, and that every facility should be afforded to them for this object.

That for all ordinary purposes, the substitution of the avoirdupois pound, ounce, and dram, with their multiples and subdivisions, to the half dram, will suffice for those persons who may wish to substitute the avoirdupois scale.

That for all such persons who may require more minute accuracy in their weighings, the use of decimal grain weights will meet their requirements.

That such grain weights for public use should be constructed of a distinctive form of material, so as to be readily distinguishable from other nearly equivalent weights.

(7.) We are of opinion that any legislation for carrying into effect the objects of these resolutions should be comprehended in the bill to be proposed to Parliament by the executive government for the amendment of the weights and measures laws, as recommended in our second report.

6. In the minutes of evidence herewith submitted to Your Majesty, bearing upon the question of the abolition of the troy scale, and upon the present use of troy weights, much information will also be found relating to the system of inspection of

weights and measures now established, and to suggested improvements in this system, including the relation of the standards department of the board of trade to the local inspectors of weights and measures. We have completed our inquiries into this large and important question, and hope very shortly to submit to Your Majesty the results of our deliberations in our next report.

We have to lament the loss of one of the members of the commission, Mr. Graham, late master of the mint, who died on the 16th September, 1869.

All which we humbly submit to Your Majesty.

G. B. AIRY, *Chairman.*
COLCHESTER.
STEPHEN CAVE.
JOHN GEORGE SHAW LEFEVRE.
EDWARD SABINE.
W. H. MILLER.
H. W. CHISHOLM.

7 OLD PALACE YARD,
February 1, 1870.

D.—Extract from the fifth report of the standards commission, 1871.

Our second [report] bore more particularly on the question of the introduction into this country of the metric system of weights and measures, and embodied the results of our inquiries and deliberations and several practical recommendations, having for their object the permissive use of the metric system in the United Kingdom, more especially for international transactions.

The abolition of troy weight was the subject of our third report, in which we referred to such legislative provisions as appeared to us to be requisite in carrying out our recommendations for the simplification of the imperial system of weight.

Letter from the Secretary of the Interior, transmitting, in response to a resolution of the House of Representatives, reports concerning the adoption of the metrical system of weights and measures.

MAY 6, 1878.—Referred to the Committee on Coinage, Weights, and Measures, and ordered to be printed.

DEPARTMENT OF THE INTERIOR,
Washington, D. C., May 4, 1878.

SIR: In reply to a resolution of the House of Representatives, passed on the 6th of November, 1877, requesting the heads of the executive departments of the government to report what objections, if any, there are to making the metrical system of weights and measures obligatory in all governmental transactions, and also in all transactions between individuals, I have the honor to transmit herewith reports upon the subject from the Commissioner of the General Land Office, the Commissioner of Patents, the Commissioner of Education, Professor F. V. Hayden, and Major J. W. Powell.

Very respectfully,

C. SCHURZ,
Secretary.

Hon. SAMUEL J. RANDALL,
Speaker of the House of Representatives.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C., March 2, 1878.

SIR: I have the honor to acknowledge the receipt of a copy of a resolution of the House of Representatives, dated November 6, 1877, which has been referred by you to this office for report.

Under the resolution referred to, heads of executive departments of the government are requested to state "what objections there are to making obligatory in all governmental transactions the metrical system of weights and measures whose use has been authorized in the United States by act of Congress, and also how long a preliminary

notice should be given before such obligatory use can be introduced without detriment to the public service;" * * * * "what objections there are, if any, to making the metrical system obligatory in all transactions between individuals; and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States."

Assuming that this office is expected to report upon questions connected with the application of the meter, as already established by law, in determining distances and areas in the prosecution of the public-land surveys, I have given that part of the subject careful consideration.

The system now in use in surveying and subdividing the public lands, with the modifications that have been suggested by experience, has controlled the public-land surveys for a period of ninety years. Under it some seven hundred millions of acres, lying in twenty-eight States and Territories, have been surveyed, and of these many millions of acres remain undisposed of.

The aggregate quantity of unsurveyed public lands in eleven partially surveyed States and Territories, and in the wholly unsurveyed Territory of Alaska, is about equal to that already surveyed.

The modifications which would necessarily follow the adoption of the meter in place of the unit of measure now in use would mainly affect the subdivisional work, by requiring the use of the *centiare*, *are*, and *hectare* in superficial measures, instead of the *acre*, which is the sole unit of superficial measure now in use in land surveys.

As the unsold lands are mingled with those already disposed of and patented, they cannot be resurveyed. Without resurvey, they must be disposed of as now subdivided. If the proposed obligatory law should go into effect, it is evident that the labors of this office in disposing of lands, the subdivisions of which are governed by two different systems, must be very considerably increased.

The Gunter chain, so long used in this branch of the public service, is of the convenient length of 66 feet. It furnishes a unit of linear measure twenty times greater than that of the metric system—a unit that accords with the magnitude of the operations in which it is employed. This measure is readily adapted to ancient surveys, in which the pole or perch was used. It determines the statute mile without division of its parts.

Wherever the public-land surveys extend they furnish the public with convenient reference in determining distances by miles and parts of a mile from point to point, and their monuments are referred to in all proceedings relating to the location and construction of public roads.

The 80 chains of the mile divide into suitable parts without fraction, and the subdivisions of lands produced thereby are equally free from the disadvantage of fractional parts of the acre.

Where from natural causes fractional subdivisions become necessary, their areas are readily determined by the Gunter chain and its decimal parts.

The legal township of the United States land surveys is approximately a rectangular tract, with sides of six statute miles. This body of land is divided into 36 sections, with sides of 80 chains, each regular section embracing, as nearly as may be, a square mile, or 640 acres.

In setting off the aforementioned tracts by the metric system, the sides of the township—six miles—would measure 9 kilometers, 6 hectometers, 5 decameters, 6,083 meters.

The sides of the system—80 chains—would measure 1 kilometer, 6 hectometers, 9,347 meters.

The contents of a section, now briefly expressed "640 acres," would be 258 hectares, 99 acres, 98.41 centares.

The contents of the convenient and briefly-described quarter-section of 160 acres, expressed in terms of the metric system, would be 64 hectares, 74 acres, 99.6 centaures.

Inferior subdivisions would, of course, be alike burdened with a multiplicity of terms, which, owing to the diminutive unit of the metrical system, can only be determined by comparatively laborious calculations.

The use of the subdivisions inferior to the hectare would in some respects resemble a return to the long-discarded "rood" and "perch" formerly recognized as subdivisions of the acre.

The effect of the immediate adoption of the meter in land surveying would be to place eleven States and Territories in the condition of having their lands subdivided under two systems widely differing in character, with units so difficult of conversion one to the other as to cause much trouble and liability to error in the transactions of business based upon land areas.

It has been claimed that the application of the proposed system of weights and measures will greatly facilitate commercial operations, more particularly the disposition of articles of export.

While this may be true, similar advantages cannot be expected from such an application at this late day to surveyed and permanently-marked subdivisions of the earth's surface, the titles to which, for ages to come, must be traced from time to time, by de-

scription, back to their origin. This class of evils will be increased in number by the ordinary changes connected with additions to and partitions of estates.

It may be asserted that some of the disadvantages of fractional linear and superficial measure can be averted by the substitution of a township of different dimensions from that now legalized, but such action, aside from other inconveniences, would involve the expense of retracement of many standard and meridian lines now marked in the field to suit the present subdivisional system.

It will, I trust, be seen from the foregoing that the substitution of the meter for the convenient unit now used in land surveys is not likely to promote the interests of this branch of the service. On the contrary, the effect will be to increase its labors and expenses, and to cause great inconvenience to the public for many years to come, and these embarrassments seem to be unbalanced by any corresponding advantage.

Governed by these views, and without desiring to influence opinion as to the effect of the proposed obligatory law in other departments of the public service, I would respectfully suggest the propriety of exempting the public-land surveys from its operations.

If, however, it should be deemed inexpedient to make such exemption, I would further suggest that a period of three years from date of passage of the proposed obligatory law be allowed this branch of the service in which to make suitable preparations in field and office to meet the demands of the new system.

The aforementioned copy of the House resolution is herewith returned.

I have the honor to be, very respectfully,

J. A. WILLIAMSON,
Commissioner.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
UNITED STATES PATENT OFFICE,
Washington, D. C., March 14, 1878.

SIR: I have the honor to acknowledge the receipt of resolution of the House of Representatives of November 6, 1877, transmitted by you for report January 17. The resolution calls for a report—

First, upon the objections, if any exist, to making obligatory in all government transactions the metric system of weights and measures, and how long notice should be given before such obligatory use can be introduced without detriment to the public; and, second, as to the objections, if any exist, to making the metric system obligatory in all transactions between individuals, and the earliest date that could be set for its obligatory use throughout the United States. It should be remarked that, so far as the business of this office is concerned, the whole question is one of very little moment.

Measurements of weights and quantity, it is true, sometimes are an important factor in inventions relating to chemical processes and composition of matter; but as such quantities are in office practice always proportionate, it is of no consequence whatever what system of measurement is used. The proportion of two to one is clear and precise, and the same under all systems.

I assume, therefore, that a report is desired from me rather as a possible expert on matters closely affecting the whole range of arts and sciences, and I shall consider the question as one of public concern, entirely outside of the interest of this office.

In the first place, the formal statement of the resolution, whereby it is proposed to consider separately the interests of the government and of the public generally upon this question, appears to be an unfortunate one. The mutual interests of the government and people, as instanced in the work of the Post-Office and of the General Land Office, are not to be separated. The dealings of the government with the public in the purchase of supplies for the Army, Navy, Indian Bureau, and all its departments, are interminable, and the use of a particular system of weights and measures in ordinary commercial transactions by the government makes its use among the people unavoidable. Some delay might occur before its use would become universal in transactions between individuals, but the abandonment of the old system, however popular, would be only a question of time. In fact, the only practicable means, in my opinion, whereby the adoption of the new system by the people of the United States could be accomplished would be by making its use obligatory in all government transactions.

The general question as to the practical advantages of the metric system over those now in use in English-speaking countries has been urged for many years. It is enough to say that almost the sole advantage claimed for it is the facility of calculation resulting from its decimal character. To a full appreciation of this advantage the people of the United States may be considered committed by the adoption of their decimal currency, which for convenience apparently leaves nothing to be desired.

It may fairly be questioned, however, whether a system which admits of decimal divisions only possesses special advantages beyond mere facility of calculation. The

division into halves and quarters has been found indispensable in our coinage. It is a natural division, which the mind readily grasps, and in its subdivisions is more readily appreciated than the division by tenths, hundredths, and thousandths. If we have a clear conception of the length of one yard, we readily grasp the idea of two yards, but can hardly intelligently grasp that of ten yards; and the reverse is strictly true. The mind does not readily vault over the wide intervals that the decimal system demands.

Hence, while from the nature of our numerical notation the use of a decimal system facilitates calculation, its advantages over others in all practical operations are subject to question, and until these advantages have been most emphatically demonstrated, I should be slow to recommend that the use of the metric system be made obligatory upon the American people. Our commercial transactions, other than domestic, must always be largely with other English-speaking people who use the same systems with ourselves, and I cannot believe it advantageous to make such a radical change as this resolution suggests except with the concurrence and concerted action of Great Britain and her colonies.

These objections to the use of the metric system in the ordinary transactions of life are, however, of trifling importance compared with others, which seem almost insurmountable. It matters little by what system of weight or measure we buy or sell our sugar or coffee, or silk or calico; the transaction is quickly at an end; and the comparative convenience of one system rather than another is, in most cases, a matter of habit only. A versatile people might quickly enough accustom themselves to the use of any ordinarily convenient system for such transactions as these; but transactions which involve the title to valuable property, and become matters of record, which are perpetuated from one generation to another, present quite a different aspect.

The history of the Mississippi Valley affords a practical illustration of the difficulty of substituting one system of land measurement for another. It is well known that the early French settlers of Saint Louis and vicinity laid out their land in *arpents*, the arpent being somewhat less than an acre, and the common unit for land measurement in use among them. Since that time the territory has passed from French into Spanish hands, and from Spanish to our own. It has been for nearly three-quarters of a century American soil. The French settlers have become merged with the emigrants from the East and Europe that have filled the Mississippi Valley. Old customs have disappeared, and the few lingering reminders of French occupation are cherished by the antiquarians with almost as much tenderness as if they were relics of Assyria or Babylon. But to-day there is scarcely a piece of real estate in the vicinity of Saint Louis that is not measured in arpents. It is so advertised, so sold, and this word lingers in the speech of the people, and the area it indicates lingers in their daily transactions with a tenacity that nothing appears to shake. Now there is nothing in the arpent which makes it a more convenient unit of measurement for land than the acre. But its retention under the circumstances is something more than a question of mere habit or use. It is because all real estate transactions are matters of permanent record, and permanent records are only changed with great difficulty. To change them involves translations, tedious and accurate computation, the discarding of original records, and opens the door to mistakes and fraud; and the possibilities of these are without end.

For a little district of a few square miles along the Mississippi River now substitute the area of our nation, with its vast estates, its little farms, its villages and town lots, all measured by acres, its great cities in which ground is measured minutely down to fractions of an inch, and consider the vast and costly records in which the titles to all this property are set forth. Consider the area of our Western States and Territories, where under the existing Congressional surveys the divisions into townships, sections, quarter-sections, &c., have become not only matters of record but actually enter into the social and political life of the people.

If three-quarters of a century have done so little to obliterate the system of land-measurement at Saint Louis under the existing circumstances, what period would be required to change the present received system of the entire country to the one proposed? Left to the operation of natural causes, it is safe to say it would never be done. Were there compensatory advantages, the authority of government might be exerted to bring about such a change; but there are none. Even the facility of calculation so sought for disappears in view of the long array of figures and fractions necessary in translating the terms of one system into the terms of the other. There is nothing to compensate for the hardship and the danger that would ensue from such a change.

The existing law makes the use of the metric system permissible. Those who find it to their advantage do and will employ it. But I would not advise legislation further.

Should it appear, however, to Congress desirable to make its use obligatory, I would urge that the expense of substituting new weights and measures in the households and shops of our people is a serious item, and ought not to be made needlessly burdensome.

It is probable that in the course of ten years on an average these would have to be replaced by new. A period somewhat shorter than this might be fixed upon, since a large proportion of those now in use are partially worn. Not less than five years nor more than ten is the limit I would suggest for making the use of the metric system obligatory in ordinary transactions, if this is determined upon, but for real-estate transactions I look upon this change as impracticable and not to be considered.

I remain, Mr. Secretary, with great respect, your obedient servant,
ELLIS SPEAR,
Commissioner of Patents.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
BUREAU OF EDUCATION,
Washington, D. C., January 12, 1878.

SIR: I have the honor to return herewith the copy of a resolution of the House of Representatives of November 6, 1877, respecting the adoption of the metric system of weights and measures, together with a paper prepared in accordance therewith, and am,

Very respectfully, your obedient servant,

JOHN EATON,
Commissioner.

The honorable the SECRETARY OF THE INTERIOR.

The resolution of the House of Representatives of November 6, 1877, respecting the adoption of the metric system of weights and measures, comprehends two questions, one as to the practicability of its adoption in all governmental transactions, and the other as to the practicability of enforcing its adoption for all transactions between individuals.

I.

The first question is best answered by considering the transactions of the Federal Government with the governments and subjects of other nations apart from its transactions with its own citizens and inhabitants.

1. The transactions of the Federal Government with foreign nations and their subjects, in which weights and measures are found useful and necessary, are chiefly under the supervision of the Secretary of the Treasury and the Postmaster-General. So far as this department is informed, no greater difficulty or delay is to be apprehended if the metric system of weights and measures be substituted for those now in use than was experienced in the adoption of the gram as the unit-weight of the international postal union, now in force.

2. The Department of the Interior, while not having such vast commercial relations to the public as the Treasury, performs various duties which render the use of weights and measures necessary. Among these I mention the following:

THE DEPARTMENT IN GENERAL.

In the purchase of wood, coal, ice, gas, stationery, carpets, curtains, window-shades, &c.

In the weighing of parcels and letters for the mail.

In all publications, correspondence, &c.

THE PATENT OFFICE.

In all dimensions of drawings, models, photo-lithographs, specifications, and other things relating to patents for inventions.

In the library.

THE PENSION OFFICE.

In the description of injuries or abnormal conditions on account of which pensions are applied for or granted.

THE GENERAL LAND OFFICE.

In the survey and sale of the public lands, and in the preparation of the necessary maps, charts, and papers connected therewith.

THE OFFICE OF INDIAN AFFAIRS.

In the purchase and distribution of food, clothing, medicine, &c., for treaty Indians, and in the papers and accounts connected therewith.

THE BUREAU OF EDUCATION.

For cartographic and bibliographical uses.

THE CENSUS OFFICE.

In the publications of the decimal census, wherever appropriate.

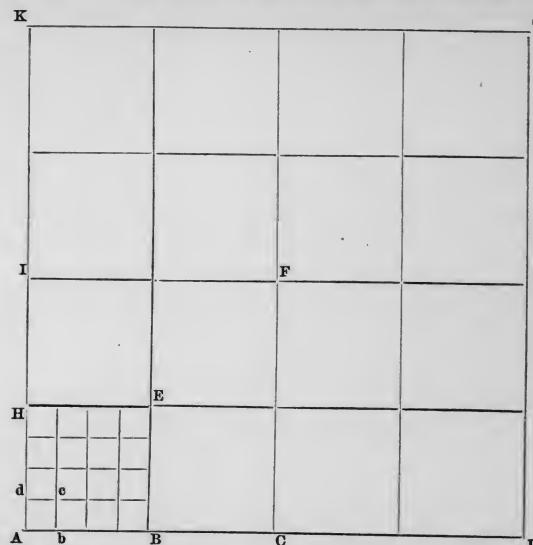
THE GEOLOGICAL AND GEOGRAPHICAL SURVEYS.

In the work of surveying and exploring, and in the construction of the maps, sections, &c., connected therewith.

THE REFORM-SCHOOL, JAIL, AND HOSPITALS.

In the record of vital and medical statistics, &c.

3. The most intimate relation which this department bears to the public is undoubtedly as the vendor of the public lands. The present system of surveying is based on the relation between the mile or unit of itinerary measure and the acre or unit of land measure, the section of one square mile containing 640 acres. Thus the survey furnishes an easily-applied measure of distances, as well as a simple and beautiful rectangular division of the public lands. These are practical advantages which should not be hastily resigned. If the hectare or the metric system be adopted as the unit of land measure, instead of the acre, the most convenient and suitable practice would be to provide that the new section of land should consist of 256 hectares, and be a square parcel of land measuring 1,600 meters each way. The sides of this square would measure 5,249 feet 4.6912 inches or 30 feet 7.3078 inches less than one mile. The following diagram, in which 5 millimeters represent 100 meters, illustrates this plan:



A b=100 meters; A B=400 meters; A C=800 meters; A D=1,600 meters, or 5,249 feet 4.6912 inches.

A b c d=1 hectare; A B E H=16 hectares, or $\frac{1}{16}$ section; A C F I=64 hectares, or $\frac{1}{4}$ section; A D G K=256 hectares, or 632,601.12831 acres.

It will be observed that the distance A D is only 30 feet 7.3078 inches less than the United States mile, and that the section A D G K is smaller than 1 square mile by

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7.39887119 acres only. A township of 36 such sections would contain 9.216 hectares. If sold for \$3.12 $\frac{1}{4}$ per hectare, the section would bring the same price as the present square mile.

II.

The second inquiry of the House committee suggests several considerations which I shall briefly review one by one; premising that the only valid reason for a change in the weights and measures of a country is the greater convenience attained. Theoretical considerations are to be discarded. In any change at the present time, three courses of action are open to us:

1. The metric system, substantially as used in France, may be substituted for our present system. Belgium, Italy, and other nations have adopted this plan. The principal practical objections to its adoption are that it would be an entire revolution of our present thoughts, apprehensions, and usages, and that the nation with which we have the closest literary, political, ethnological, and commercial connections, to wit, Great Britain, has not adopted it.

2. The standards now in use, the yard, the gallon, the bushel, the mile, and the section, may be slightly modified so as to have a metric value easily convertible into the corresponding metric units of measure. This has been done by the German Empire. The imperial stab is a meter, the kanne is a liter, the schoppen is a half-liter; the fass is a hectoliter, the scheffel is a half-hectoliter, the pfund is a half-kilogram. These names, once belonging to many slightly different units, and thereby causing endless confusion and pecuniary loss, now have a definite and uniform value all over the empire, and their new values have been accepted, not only without objection, but with general satisfaction.

3. We may retain the yard, gallon, bushel, pound, and acre, and by the decimal system of multiplication and division derive a new and more convenient series of weights and measures therefrom. We have used the decimal system in our coinage theoretically, the series from low to high being the mill, cent, dime, dollar, and eagle. Practically, we use the mill only in expressing the rates of taxation (as three mills to the dollar), the cent and dollar in ordinary business, the dime as a subsidiary coin, the eagle never nowadays, as the half-eagle is a more convenient coin. We use in surveying the link of 7.92 inches and the Gunters chain of 792 inches or 66 feet, the square chain (of 16 square rods), and the acre of ten square chains.

Sweden adopted the decimal notation some years ago. I am informed that, after a full trial, that country has decided to adopt the metric system on and after January 1, 1889. This seems to indicate that the decimal notation is only a palliative measure in practice.

The metric system of weights and measures has been adopted, in one of the two ways above mentioned, by the Argentine Republic, Bolivia, Brazil, Chili, the United States of Colombia, Ecuador, Mexico, Peru, and Uruguay, in the Americas; by Austria-Hungary, Belgium, France, the German Empire, Greece, Holland, Italy, Portugal, Roumania, Spain, and Switzerland in Europe; by the British in the East Indian possessions, and by the viceroy of Egypt.

It is permitted in Great Britain and her colonies, and in our own country; these and Russia are the only commercial nations of any importance where it is not legally obligatory.

Should the metric system be adopted for ordinary use in this country, or should our standards be modified so as to be readily compared therewith, it is obvious that the influence on certain industries would be very great.

Timber, now sawed 16 feet long, would then probably have to be 5 meters long, an excess of nearly 5 inches; a thickness of 2 $\frac{1}{4}$ centimeters would correspond near enough to our inch.

A cord of firewood would be 2.50 meters long, 1.25 meters wide and high, and would contain about 136 cubic feet, instead of 128, as now.

A new ton of 1,000 kilograms, equal to somewhat more than 2,205 avoirdupois pounds, would be an acceptable substitute for the "long" and "short" tons now in use.

A new gallon of 4 liters capacity, and a new bushel equal to 4 decaliters, would do away with much of the confusion inevitable under the use of the present dry and liquid measures.

The Federal Government can assist in the general comprehension of the metric system, preparatory to its obligatory use by the people, in various ways.

It can use it exclusively in all instruments of precision prepared for its departments, offices, and employees.

It can construct all maps, charts, and diagrams by the system.

It can use the system in all purchases, surveys, and sales.

It can use it in all its publications, legislative, executive, and judicial.

It can require a thorough knowledge of and familiarity with the system of candidates for admission to its military, naval, medical, and civil service.

As an example of the way in which government can influence matters of this kind, I give one or two items about stationery:

Writing-paper is now generally supplied by the trade, in reams containing 480 sheets; the official ream might be made 500 sheets; the weight might be expressed in kilograms; the rulings for ordinary styles one centimeter apart.

Official envelopes, and all envelopes supplied by the Post-Office Department, could be made to carry a decimeter scale, divided into centimeters and millimeters, along their lower margin, properly indicated.

Ink and mucilage might be ordered in bottles containing a liter instead of a quart.

I would also suggest that the use of the centigrade thermometer instead of Fahrenheit's, and of barometers graduated to millimeters instead of fractions of an inch, should accompany any substitution of the metric for the present system.

Some confusion in the discussion of this subject has occurred by the slightly different values given to the meter. The calculation of Capt. Alexander R. Clarke, of the British ordnance survey office, is probably the most correct, *i.e.*, that the meter is equal to 39.370432 inches.

ADDENDUM.

I am informed that Dr. Franklin B. Hough, formerly superintendent of the New York State census, has revised some interesting statistics prepared by him in regard to the different weights in avoirdupois pounds of a bushel of various commodities as provided by the laws in certain States and Territories. Appreciating the value of such a statement in connection with the subject of this paper, I have requested him to supply me with a copy of his table. This he has done, and with it has written a letter, from which the following extracts are made:

* * * I herewith submit a table of weights of a bushel of grain and other commodities, recently prepared by me for use in a work now in course of publication, designed to facilitate the preservation of statistical records of farm industries. * * *

An examination of the table will show at a glance that while in some instances sufficient uniformity exists—as, for example, in the weight of wheat, which is 60 pounds to the bushel in every case where it is mentioned—yet that there is a singular discrepancy in other cases that might lead to serious misunderstanding in dealings between citizens of different States.

As an instance of this disparity, it may be noticed that 1,000 bushels of barley, bought in the State of Kansas at 48 pounds to the bushel, would become 1,500 bushels in New Orleans, where a contract for delivery would, in the absence of agreement to the contrary, be satisfied at the rate of 32 pounds to the bushel.

In the case of rye, 1,000 bushels would, by the same transfer, become 1,750 bushels; and in other cases differences might arise which, if not so great, are manifestly as unjust in the settlement of commercial accounts.

* * * Instances are not wanting of an exception to the rule in favor of certain counties, so that the statute weight of a bushel was not uniform at a given time throughout the State. An instance of this occurred in an act passed March 14, 1844, by the legislature of New Jersey, making a bushel of corn 55 pounds in Salem County, while it was 56 pounds in the rest of the State.

In one instance, an act now in force discriminates in favor of a commodity produced within the State as against the same brought from a neighboring State. This was by a law of Indiana, approved March 7, 1863, fixing the weight of a bushel of mineral coal at 70 pounds if mined within the State, and at 80 pounds if mined without and sold within the State.

As a general rule, these weights as fixed by law are declared to be intended as a standard of reference in the absence of an expressed agreement, but an instance may be cited in which this option of special contract is *forbidden*, and either one of the parties may obtain a forfeiture from the other if he is unwilling to accept the weight as fixed by law. I refer to the act of the Maine legislature of February 17, 1874, fixing the weight of a bushel of apples at forty-four pounds, and forbidding agreement to the contrary, under a forfeiture of 25 cents to each bushel. * * *

Custom has, in some markets, already fixed upon the *cental* or one hundred pounds avoirdupois as a unit in the sale of grains, and if this were adopted as the measure of all commodities mentioned in the table under consideration, there would be no difficulty in adjusting prices to this standard in whatever might be bought and sold.

Referring back to the differences noticed in the weights of a bushel between different States, there can be no doubt but that an appeal to the courts of any one of the States would lead to a decision in accordance with the laws of that State in fixing the weight of a bushel of grain. It is further evident that decisions in State courts of last appeal might be as discordant upon this subject as the laws themselves.

But the Constitution of the United States provides that "full faith and credit shall be given in each State to the public acts, records, and judicial proceedings of every other State. And the Congress may by general law prescribe the manner in which such acts, records, and proceedings shall be proved, and the effect thereof."

It is easy to understand how the "manner of proof" might be provided for; much easier than to foresee in this instance "the effect thereof"; but should a case of difference between citizens of different States, arising from a misunderstanding on this subject, be brought for decision in the Supreme Court of the United States, it is evident that great difficulty would be experienced in giving that equal credit due to each State in its public acts and judicial decisions where each was equally positive and directly opposed to the other.

On carefully examining other statutes defining the weights and measures of quantities other than the bushel, we find differences between States that ought not to exist. The number of cubic inches in a struck bushel differs slightly, and the contents of a bushel of heaped measure considerably. The gallon of milk in Vermont and Massachusetts is 231 cubic inches, or "wine measure," while in New Hampshire it is 232 cubic inches, or "beer measure." The superficial area of a half-bushel (a matter of consequence in selling by heaped measure) is not uniform, and the contents of a barrel, as defined by State laws, is different in different States.

Extending these comparisons to other units of measure, we find notable discordance in the laws relating to the inspection of staves, lumber, shingles, and other forest products; differences that ought not to exist, and which are liable to lead to misunderstandings, by affording opportunities for fraud. The differences that exist between the inspection laws of the several States require a careful study before venturing upon general legislation, to the end that the true wants of the country and the equities of trade may be served without prejudice to any section or interest.

Number of pounds (avoirdupois) in a bushel of various commodities, according to the laws of certain States and Territories.

States and Territories.	Cereals. ¹	Legumes.	Meat, etc.	Fruits. ²		Seeds. ¹¹	Forage.	Other.		
				Maize.	Maize.					
					Apples.					
Arizona	45	54	32	56	260	40	...	...
California	50	52	32	54	260	40	...	...
Colorado	48	56	70	32	56	60	52	50		
Connecticut	48	56	70	32	56	40	48	50		
Dakota	48	56	70	32	56	60	50	50		
Delaware	48	56	70	32	56	50	50	50		
Illinois	48	56	70	32	56	60	52	50		
Indiana	48	56	68	32	56	50	48	50		
Iowa	48	56	70	33	56	60	52	50		
Kansas	48	56	70	32	56	60	50	50		
Kentucky	47	56	70	32	56	40	56	50		
Louisiana	32	56	32	32	56	40	56	50		
Maine	48	56	30	64	48	60	50	50		
Maryland	47	56	26	56	48	60	50	44		
Massachusetts	48	56	32	56	48	60	50	50		
Michigan	48	56	70	32	56	60	52	50		
Minnesota	48	56	32	56	42	50	50	50		
Missouri	48	56	32	56	60	52	50	50		
Montana	48	56	35	56	60	52	50	50		
Nebraska	48	56	70	34	56	40	52	50		
New Hampshire	48	56	30	56	60	50	50	50		
New Jersey	48	56	30	56	60	50	50	50		
New York	48	59	32	56	62	48	60	50		
Ohio	48	56	70	32	56	60	50	50		
Oregon	46	56	36	56	42	50	50	44		
Pennsylvania	47	56	30	58	48	50	50	50		
Rhode Island	48	56	32	56	50	50	50	52		
Vermont	48	56	32	56	60	46	50	45		

METRIC SYSTEM.

States and Territories.	Cereals. ¹		Legumes.		Meat, etc.		Fruits. ²		Seeds. ¹¹	
	Maize.		Maize.		Apples.		Oil.		Forage.	
	Maize.	Maize.	Maize.	Maize.	Apples.	Oil.	Oil.	Forage.	Other.	
Virginia	48	70	32	56	30	52	40	50	38	40
Washington	45	56	36	56	32	52	40	50	38	40
West Virginia	48	56	32	56	30	52	40	50	38	40
Wisconsin	46	56	32	56	30	52	40	50	38	40

¹ The wheat bushel is 60 lbs., except in Rhode Island, where no weight is mentioned.

² Small white beans 60; other beans 55.

³ White beans.

⁴ Black-eyed peas.

⁵ Hominy in Ohio, "cracked corn".

⁶ Sifted meal 44; unsifted meal 48.

⁷ In Virginia 22 lbs. of peanuts, or 57 lbs. of chestnuts, make a bushel; in Iowa cher-

ries 40 lbs.; peaches and quince 48 lbs.; in Oregon, peaches 45 pounds; in Michigan

dried plums 25 lbs., crabapples 40 lbs.

⁸ Unpeeled peaches 32.

⁹ Raspberries and strawberries the same, "raps, currants, and gooseberries 40 lbs.

¹⁰ Also all other berries 32.

¹¹ Rape-seed in Wisconsin 50 lbs., hemp grass in Iowa 45 lbs., orchard-grass in Michigan

14 lbs., red top seed in Virginia 12 lbs., cotton-seed in Missouri 33 lbs.

METRIC SYSTEM.

States and Territories.	Roots.		Other commodities. ¹⁶		Other commodities. ¹⁶		Other commodities. ¹⁶		Other commodities. ¹⁶	
	Beets.		Carrots.		Onion-seeds.		Potatoes.		Sweet potatoes.	
	Beets.	Carrots.	Onion-seeds.	Carrots.	Onion-seeds.	Potatoes.	Sugar-beets.	Turips.	Rutabagas.	Coat mineral.
Arizona	57	50	60	45	60	60	60	1130	60	80
California	55	50	60	52	60	60	60	80	60	80
Colorado	60	50	60	46	60	60	60	80	60	80
Connecticut	57	52	60	57	60	60	55	80	60	80
Dakota	57	52	60	60	60	60	55	80	60	80
Delaware	57	52	60	60	60	60	55	80	60	80
Illinois	48	54	60	60	60	60	55	70	50	70
Indiana	57	50	60	50	60	60	55	80	60	80
Iowa	57	50	60	50	60	60	55	80	60	80
Kansas	57	50	60	50	60	60	55	80	60	80
Kentucky	57	50	60	45	60	60	55	70	50	70
Louisiana	50	60	60	52	60	60	55	1430	60	80
Maine	57	52	60	57	60	60	55	80	60	80
Maryland	57	52	60	57	60	60	55	80	60	80
Massachusetts	54	52	60	54	60	60	56	80	60	80
Michigan	54	52	60	54	60	60	56	80	60	80
Minnesota	57	50	60	50	60	60	55	80	60	80
Missouri	50	56	57	50	60	60	55	80	60	80
Montana	57	52	60	57	60	60	55	80	60	80
Nebraska	57	52	60	57	60	60	55	80	60	80
New Hampshire	57	52	60	57	60	60	55	80	60	80
New Jersey	57	52	60	57	60	60	55	80	60	80
New York	57	52	60	57	60	60	55	80	60	80
Ohio	50	56	57	50	60	60	55	80	60	80
Oregon	60	60	60	60	60	60	60	1676	60	80
Pennsylvania	60	60	60	60	60	60	60	1870	60	80
Rhode Island	60	50	57	52	60	60	55	80	60	80
Vermont	57	52	60	57	60	60	55	80	60	80
Virginia	57	52	60	57	60	60	55	80	60	80
Washington	50	56	57	50	60	60	55	80	60	80
West Virginia	50	56	57	50	60	60	55	80	60	80
Wisconsin	50	56	57	50	60	60	55	80	60	80

¹² Turnip-beets 60.

¹³ All root crops, except onions, 60.

¹⁴ Common English turnips.

¹⁵ Turnip-beets 60.

¹⁶ In Pennsylvania 40 lbs. of coke make a bushel;

in Iowa 130 lbs. of sand make a bushel.

¹⁷ At Pittsburgh—75 lbs. at Greenburg.

¹⁸ Michigan salt.

¹⁹ Foreign ground salt.

²⁰ Fine foreign salt.

²¹ Coarse foreign salt.

²² Stone lime.

²³ Fine lime.

²⁴ Coarse lime.

²⁵ Lime.

²⁶ Unslaked lime.

²⁷ Hard for plaster.

²⁸ Lime.

²⁹ Coarse salt.

³⁰ Salt.

³¹ Coarse salt.

³² Salt for plaster.

³³ Lime for plaster.

³⁴ Lime.

³⁵ Lime.

³⁶ Lime.

³⁷ Lime.

³⁸ Lime.

³⁹ Lime.

⁴⁰ Lime.

⁴¹ Lime.

⁴² Lime.

⁴³ Lime.

⁴⁴ Lime.

⁴⁵ Lime.

⁴⁶ Lime.

⁴⁷ Lime.

⁴⁸ Lime.

⁴⁹ Lime.

⁵⁰ Lime.

⁵¹ Lime.

⁵² Lime.

⁵³ Lime.

⁵⁴ Lime.

⁵⁵ Lime.

⁵⁶ Lime.

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OFFICE OF THE UNITED STATES GEOLOGICAL AND
GEOGRAPHICAL SURVEY OF THE TERRITORIES,
Washington, D. C., March 20, 1878.

SIR: In reply to your communication of March 11, asking an expression of my views in regard to the resolution of Mr. Clark, of Missouri, passed by Congress November 6, 1877, I beg to state, first, that among the majority of scientific men in all countries, a uniform system of weights and measures for the entire civilized world is held as a matter of the highest importance. As far back as 1821, Hon. John Quincy Adams used the following forcible language:

"Uniformity of weights and measures, permanent, universal uniformity, adapted to the nature of things, to the physical organization and moral improvement of man, would be a blessing of such transcendent magnitude that if there existed upon earth a combination of power and will adequate to accomplish the result by the energy of a single act, the being who should exercise it would be among the greatest of benefactors to the human race."

So far as the work of this survey is concerned, there is but little difference in the two systems. In our map-work it is unimportant whether we use meters or miles, frequently using both.

There are special cases where the metric system might be made obligatory immediately, as in the Post-Office Department, but among individuals or in English-speaking countries it would seem quite impossible to make the metric system compulsory during the present generation. Our people cannot think in that system, and must therefore consume a certain amount of time in translating from one into the other.

The metric system will probably be required to be introduced into the common schools to the exclusion of our English method.

It is believed that all objections to the metric system will be entirely overcome in the progress of the times.

Very respectfully, your obedient servant,

F. V. HAYDEN,
United States Geologist.

Hon. CARL SCHURZ,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOGRAPHICAL AND GEOLOGICAL
SURVEY OF THE ROCKY MOUNTAIN REGION,
Washington, D. C., May 3, 1878.

SIR: I have the honor to acknowledge the receipt of your letter of March 11, communicating to me the resolution of the House of Representatives, on motion of Hon. John B. Clark, Jr., of Missouri, namely:

"Resolved, That the heads of the executive departments of the government be, and they are hereby, requested to report to this House, at as early a date as practicable, what objections, if any, there are to making obligatory in all governmental transactions the metrical system of weights and measures, whose use has been authorized in the United States by act of Congress," &c.

In which letter you also desire me to give an expression of my opinion upon the subject referred to in said resolution. I have the honor to reply as follows:

It appears to be the conviction of many able men who have studied the subject, that the adoption of the metric system now employed by France, Germany, and other countries, would be beneficial to the people of this country in many ways, by diminishing the labor of computation and promoting the accuracy of records and accounts, the proper keeping of which is so essential to and intimately associated with the welfare of the entire people. There can be no question that if all computations could be at once settled upon the basis of this system, and if those who daily make use of computations were as thoroughly habituated to it as they are to the heterogeneous system now in use, the gain would be very great. On the other hand, it cannot be denied that much difficulty must be encountered and no small amount of inconvenience entailed in making the transition, and the question is resolved into the interior one of whether the advantages to be secured by the change would more than compensate for the difficulties of making it. While the affirmative view of this question appears to me to be the only reasonable one, I think that many difficulties may be recognized.

So far as relates to the adoption of the metric system in governmental transactions, the principal difficulties seem to me to be as follows: All of the laws of the United States which involve the records and computations of weights and measures specify the quantities in terms of the existing system. The laws relating to the duties on imports and rates of excise, other than *ad valorem*, specify pounds, tons, feet, yards, gallons, &c. The laws relating to the lands and their metes and bounds specify the cur-

rent units of linear or superficial measures. In governmental transactions, rates of purchase, sale, and taxation are usually so adjusted to weights and measures as to be easily expressed in simple numbers and very simple fractions. For example, when lands are sold the price is a dollar and an easily expressed fraction of a dollar per *acre*. The duty upon cloth is a definite number of cents per *yard*. The tax on spirits is a definite number of cents per *gallon*. To change the mode of computation in these transactions to the metric system without any alteration in the present prices and rates of taxation would involve the use of inconvenient decimal fractions. To obtain that simplicity of computation which is the main object and utility of the metric system, it would be necessary to change the quantitative specifications of the law. Take an example: The present tax upon distilled spirits is 90 cents per proof-gallon; if the metric system were to be employed, without any change in the rate of taxation, the law would have to read that the tax per proof *litre* should be 23.776124 cents, an incommensurable quantity more difficult to employ than the present one, and the most obvious way of meeting the difficulty would be to make a slight alteration in prices, excise, and duty rates, insufficient to affect commercial interests, but sufficient to secure the required simplicity and accuracy of specifications. This difficulty does not, however, appear to be insuperable, for if Congress is fully satisfied that the gain from the use of the metric system is more than sufficient to compensate the acknowledged difficulties of its introduction, the remedy is simple and obvious.

There is another difficulty which must be apparent to all who have given the subject even a cursory examination. The government is frequently brought into relations, involving the use of weights and measures, with uneducated persons whose powers of computation are limited, and whose ideas are so thoroughly imbued with the present system that the metric system is almost beyond their grasp, and who would be compelled to rely upon the good faith and services of others in transactions where the law would hold them responsible for a full and intelligent comprehension of their own acts and their consequences. I believe, however, that we are more apt to overrate than to underrate the difficulties that may arise from this source. It is not probable in any event that legislation would be resorted to in order to introduce the metric system violently, as the fact would be recognized that the people must grow into and adopt it gradually, if at all, and that this gradual adoption would in itself furnish a reasonable safeguard against such danger.

It would not doubt be easy to suggest many sources of difficulty which in a general way are analogous to those already stated, and of which the foregoing are intended merely as examples. If the inquiry of the committee asking for objections refers to insuperable objections, I can only state that I see none of that character.

There are certain facts worthy of consideration in this connection. A very large number, probably a great majority of all the citizens of the United States, are already so fully informed on this subject that a change to the new system is by them deemed wise. In very many of the public schools of the United States, and the private schools also, the metric system is taught; and the method of determining in units of the new system the value of quantities in the old is already familiar to the youth of the country. It is desirable that this interest in the metric system should not abate, but rather that some stimulus be given to the acquirement of a more thorough knowledge of and familiarity with it. For this purpose I consider that it would be wise to introduce its use into some departments of the government at an early date.

Having made as careful a survey as time and circumstances would permit of the general scope of government business, I have been led to the opinion that it might be introduced into governmental transactions relating to international commerce, into the postal service, and into all that portion of the business of the General Land Office which pertains to the public lands yet unsurveyed. In these branches of the government little inconvenience will be felt by private individuals, as the business will be transacted by government officers and employés who are, or should be, competent to the task. More than one-half of the whole area of the United States, including Alaska, is yet unsurveyed and undisposed of. While over a portion of this great area divisional surveys are unnecessary, yet the greater part must eventually be surveyed antecedent to the conveyance of titles to individuals.

If the metric system is finally to prevail in this country, it is desirable that these lands should be measured and conveyed in units of the new system.

While I deem it wise to introduce the new system gradually, it would be unfortunate to check the growing interest in it by a rapid change that would at once precipitate on the people all the difficulties inevitable to the transition. The final accomplishment of this good might thereby be indefinitely postponed.

Should it be thought desirable to introduce the new system more extensively into the business of the government, I would suggest that it might be adopted in transactions relating to the internal revenue and government transportation; but the same precaution should be used in these cases as in those mentioned above, namely, that in the quantitative specifications of the law, and all contracts made under the law, rates should be adjusted to quantities, so as to be expressed in a simple manner; for if this

is neglected the new method will be so burdensome as to bring the system into popular disrepute. I entertain the opinion, however, that it will be wiser to postpone its introduction in the latter-mentioned cases until it has been thoroughly tried in the former.

The resolution of the committee also inquires, "How long a preliminary notice should be given before such obligatory use can be introduced without detriment to the public service?" So far as it relates to transactions between the government and individuals, I see no reason why, if it is to be introduced at all, it cannot be introduced now to the extent mentioned above, giving only such preliminary notice as would be necessary to make all persons who may be concerned fully apprised of the intention of the government. For this purpose a single year will, in my opinion, be ample. It should be borne in mind, in this connection, that the transactions of the government differ from those between individuals in the following important particulars: They are more deliberate, and are matters of record, involving no dangers nor difficulties except such as the intelligence of its employés is presumably quite adequate to meet, whereas the transactions between individuals, over the counter of the retail store, on the street, or in the farm-yard, are frequently without record or voucher, and sometimes made by individuals of small education. In such cases a sudden change in the basis of weights and measures might produce serious embarrassments.

The resolution further inquires, "What objections there are, if any, to making the metrical system obligatory in all transactions between individuals; and what is the earliest date that can be set for the obligatory use of the metrical system throughout the United States?" To the first part of this question one general and comprehensive answer may, I think, be given—that the only objection is the inconvenience of making the change. The magnitude of this objection is a purely practical question, which legislators are, of all men, probably the most competent to estimate correctly.

In all business transactions relating to machinery and architecture, and in the practical use of the metric system in these industries, the inconvenience will be great. In land measures its introduction will but slightly inconvenience the people at large, for the measurement of land is practically relegated to skilled persons, as engineers and surveyors; and the conveyancing of lands to persons skilled in that branch of business.

These examples will illustrate the nature of the problem to be solved. It is one of exceeding complexity, affecting many interests in diverse ways, and I deem it wise to postpone the subject of making the new system obligatory between individuals to some future time, until experience in its practical use by the government shall more fully demonstrate the many advantages to be derived therefrom.

If the general use of this system is eventually compelled by law, it will be reasonable to retain for a considerable time the legality of both systems prior to the last step in the transition. This will involve a contemporaneous use of the two systems, in itself a serious inconvenience. This, however, is obviously a part of the price which the government and people will be compelled to pay for ultimate accomplishment of a good work.

In the above statement the wisdom of adopting the metric system is postulated. As long as we have a denary or decimal system of numeration, a decimal system of weights and measures is the most simple and convenient. Improvements might be suggested in the new system, as a decimal system, but from the fact that such improvements are of minor importance, and the further fact it is adopted already by some great and enlightened nations, these considerations have slight weight, and an attempt to introduce a new system of numeration as well as a new system of weights and measures would be a change of such magnitude that it may be well at present to consider it impracticable.

I am, with great respect, your obedient servant,

J. W. POWELL,
In Charge United States Geographical and Geological Survey,
Rocky Mountain Region.

Hon. CARL SCHURZ,
Secretary of the Interior.

METRIC SYSTEM.

CHAPTER IV.

CORRESPONDENCE OF STATE DEPARTMENT IN RELATION TO METRIC SYSTEM.

Message from the President of the United States, transmitting a communication from the Secretary of State in response to a resolution of the House of Representatives in relation to the convention for establishing an International Bureau of Weights and Measures.

JUNE 11, 1878.—Referred to the Committee on Coinage, Weights, and Measures and ordered to be printed.

To the House of Representatives:

In answer to a resolution of the House of Representatives of the 27th May, ultimo, I transmit the response of the Secretary of State, accompanied by a copy of the papers called for by the resolution.

R. B. HAYES.

WASHINGTON, June 11, 1878.

DEPARTMENT OF STATE,
Washington, June 10, 1878.

The Secretary of State, to whom was referred the resolution of the House of Representatives, passed on the 27th ultimo, requesting him to communicate to that House "the papers relative to the convention for establishing an International Bureau of Weights and Measures, lately ratified by the Senate," has the honor to lay before the President copies of the papers called for in that resolution, a list of which is hereto annexed.

Respectfully submitted.

WM. M. EVARTS.

The PRESIDENT.

List of papers.

- No. 1. Metric convention, signed at Paris, May 20, 1875. (Translation.) [See pp. 36-42.]
- No. 2. Mr. Hilgard to Mr. Fish. December 13, 1872. [See pp. 46-48.]
- No. 3. Marquis de Noailles to Mr. Fish. Washington, January 10, 1873. (With an inclosure.)
- No. 4. Mr. Boutwell to Mr. Fish. Washington, January 30, 1873. (With an inclosure.)
- No. 5. Marquis de Noailles to Mr. Fish. Washington, February 15, 1873. (With an inclosure.)
- No. 6. Mr. Richardson to Mr. Fish. Washington, March 15, 1873. (3 inclosures.)
- No. 7. The same to the same. Washington, June 18, 1873.
- No. 8. Marquis de Noailles to Mr. Fish. Washington, December 22, 1873.
- No. 9. Mr. Davis to Mr. Richardson. Washington, January 3, 1874.
- No. 10. Mr. Richardson to Mr. Fish. Washington, February 6, 1874. (With an inclosure.)
- No. 11. Professor Hilgard to Mr. Fish. Washington, September 15, 1874. [Extract.]
- No. 12. Mr. Cadwalader to Mr. Bristow. Washington, September 23, 1874. [Extract.]
- No. 13. Mr. Bristow to Mr. Fish. Washington, October 24, 1874. (With an inclosure.)
- No. 14. Mr. Cadwalader to Mr. Bristow. Washington, November 4, 1874.
- No. 15. Mr. Bartholdi to Mr. Fish. Washington, November 23, 1874.
- No. 16. Mr. Fish to Mr. Bristow. Washington, November 30, 1874.
- No. 17. Mr. Bristow to Mr. Fish. Washington, January 9, 1875. (With an inclosure.)
- No. 18. Mr. Fish to Mr. Bristow. Washington, January 13, 1875.
- No. 19. Professors Henry and Hilgard to Mr. Fish. Washington, January 13, 1875. With a memorandum inclosed.)
- No. 20. Mr. Bristow to Mr. Fish. Washington, January 16, 1875.

METRIC SYSTEM.

No. 21. Mr. Fish to Mr. Bartholdi. Washington, January 18, 1875.
 No. 22. Mr. Fish to Mr. Washburne. No. 670. Washington, January 19, 1875.
 No. 23. Mr. Fish to Mr. Bristow. Washington, January 22, 1875.
 No. 24. Mr. Washburne to Mr. Fish. No. 1094. Paris, February 2, 1875.
 No. 25. Mr. Bartholdi to Mr. Fish. Washington, February 20, 1875.
 No. 26. Mr. Washburne to Mr. Fish. No. 1110. Paris, March 1, 1875. (With an inclosure.)
 No. 27. The same to the same. No. 1116. Paris, March 15, 1875. (With an inclosure.)
 No. 28. The same to the same. No. 1124. Paris, March 26, 1875. (With an inclosure.)
 No. 29. The same to the same. No. 1127. Paris, April 8, 1875. (With an inclosure.)
 No. 30. The same to the same. No. 1131. Paris, April 14, 1875.
 No. 31. The same to the same. No. 1134. Paris, April 16, 1875.
 No. 32. Mr. Bristow to Mr. Fish. Washington, April 17, 1875. (With an inclosure.)
 No. 33. Mr. Fish to Mr. Bristow. Washington, April 24, 1875.
 No. 34. Mr. Washburne to Mr. Fish. No. 1140. Paris, April 29, 1875. (With an inclosure.)
 No. 35. Professor Hilgar to Mr. Cadwalader. Washington, May 3, 1875. (With inclosed copy of resolutions of the National Academy of Sciences, April 22, 1875.)
 No. 36. Mr. Conant to Mr. Fish. Washington, May 5, 1875.
 No. 37. Mr. Fish to Mr. Bristow. Washington, May 8, 1875.
 No. 38. Mr. Cadwalader to Mr. Washburne. No. 700. May 11, 1875.
 No. 39. Mr. Bristow to Mr. Fish. Washington, May 14, 1875.
 No. 40. Mr. Fish to Mr. Washburne. Telegram. Washington, May 17, 1875.
 No. 41. Mr. Fish to Mr. Bristow. Washington, May 18, 1875.
 No. 42. Mr. Washburne to Mr. Fish. No. 1167. Paris, May 28, 1875. (With an inclosure.)
 No. 43. The same to the same. No. 1169. Paris, May 28, 1875.
 No. 44. Mr. Cadwalader to Mr. Washburne. No. 713. Washington, June 11, 1875.
 No. 45. Mr. Hitt to Mr. Fish. No. 1264. Paris, December 10, 1875. (With an inclosure.)
 No. 46. Mr. Bristow to Mr. Fish. Washington, December 17, 1875. (With an inclosure.)
 No. 47. Mr. Fish to Mr. Hitt. Telegram. Washington, December 18, 1875.
 No. 48. Mr. Hitt to Mr. Fish. Telegram. Paris, December 19, 1875.
 No. 49. The same to the same. No. 1270. Paris, December 20, 1875. (With an inclosure.)
 No. 50. Mr. Cadwalader to Mr. Bristow. Washington, December 28, 1875.
 No. 51. Mr. Cadwalader to Mr. Hitt. No. 770. Washington, December 28, 1875.
 No. 52. Mr. Washburne to Mr. Fish. No. 1284. Paris, February 4, 1876.
 No. 53. Mr. Fish to Mr. Bristow. Washington, February 17, 1876. [See p. 59.]
 No. 54. Mr. Bristow to Mr. Fish. Washington, March 6, 1876. (With inclosures.)
 [See p. 60.]
 No. 55. The same to the same. Washington, March 6, 1876. (With an inclosure.)
 No. 56. Mr. Fish to Mr. Washburne. No. 787. Washington, March 8, 1876.
 No. 57. Mr. Fish to Mr. Bristow. Washington, March 9, 1876.
 No. 58. Mr. Washburne to Mr. Fish. No. 1372. Paris, September 21, 1876.
 No. 59. Mr. Morrill to Mr. Fish. Washington, October 20, 1876. (With an inclosure.)
 No. 60. Mr. Cadwalader to Mr. Washburne. No. 848. Washington, October 25, 1876.
 No. 61. Mr. Washburne to Mr. Fish. No. 1404. Paris, November 15, 1876.
 No. 62. General Noyes to Mr. Evarts. No. 52. Paris, January 15, 1878. (With inclosures.)
 No. 63. The same to the same. No. 63. Paris, February 22, 1878. (With inclosures.)
 No. 64. Mr. Outrey to Mr. Evarts. Washington, March 6, 1878. (With an inclosure.)
 No. 65. Mr. Evarts to Mr. Outrey. Washington, March 25, 1878.
 No. 66. Mr. Evarts to General Noyes. No. 43. Washington, March 27, 1878.
 No. 67. Mr. Sherman to Mr. Evarts. Washington, March 29, 1878. (With an inclosure.)

No. 3.

Marquis de Noailles to Mr. Fish.

[Translation.]

LEGATION OF FRANCE,
Washington, January 10, 1873. (Received January 11.)

Mr. SECRETARY OF STATE: I have the honor to transmit to your excellency the inclosed dispatch, which has just been sent to me by the minister of foreign affairs of the French Republic.

METRIC SYSTEM.

The French section, which has been intrusted by the International Metre Commission with the preparation of the standard metres and kilogrammes which will be needed by the various governments represented in said commission, desires to know how many of these standards it must have made. The minister of agriculture and commerce therefore wishes to know the number of *mètres à traits* or *mètres à bouts*,* as also the number of kilograms of iridized platinum which the Government of the United States requires.

The price of a metre will probably not exceed four thousand francs, nor that of a kilogramme fifteen hundred francs.

I shall be happy, Mr. Secretary of State, to place myself at the service of your excellency in order to transmit the reply which it may please your excellency to make on this subject to the department of foreign affairs of France.

Be pleased to accept, Mr. Secretary of State, the assurances of my very high consideration.

MARQUIS DE NOAILLES.

Count De Rémusat to Marquis de Noailles.

[Translation.]

MINISTRY OF FOREIGN AFFAIRS,
DIVISION OF CONSULATES AND COMMERCIAL AFFAIRS,
Versailles, December 6, 1872.

SIR: The French section, which has been intrusted by the international metre commission with the preparation of the standard metres and kilogrammes which will be needed by the various governments represented in said commission, desires to know how many of these standards it must have made.

I will therefore thank you, sir, to enable me to comply with the request addressed to me by the minister of agriculture and commerce, by informing me as soon as possible of the number of metres, whether *à traits* or *à bouts*, and also of the number of kilograms of iridized platinum, which will be required by the Federal Government.

The price of a metre will probably not exceed, all expenses included, the sum of 4,000 francs, and the price of a kilogramme will probably not exceed 1,500 francs. M. Teisserenc de Bort adds that the sum whereby payment is to be made for standards must be placed at the disposal of the French Government, so that the orders for payment may be delivered by the minister of commerce according to the method adopted for the expenses hitherto incurred by the metre commission.

Receive, sir, &c.,

RÉMUSAT.

No. 4.

Mr. Boutwell to Mr. Fish.

TREASURY DEPARTMENT,
January 30, 1873.

SIR: I have the honor to acknowledge the receipt of the communication of the honorable Secretary of State, dated the 17th instant, covering translation of a note from the Marquis de Noailles, the French minister (with accompaniment), in which inquiry is made in regard to the number of standard metres and kilogrammes prepared by the International Metric Commission that will be required for the use of this government, and requesting that this department furnish at its earliest convenience such information as will enable the Department of State to answer the inquiry referred to above. In reply, I respectfully transmit a copy of a communication from Prof. J. E. Hilgard, assistant superintendent of weights and measures, received at this Department in response to an inquiry addressed to that office upon the subject, from which it appears that a single copy of each standard will be sufficient, to wit:

One *mètre à traits* (or metre defined by lines);One *mètre à bouts* (or metre defined by its ends);

One kilogramme;

And that the estimated expense of these standards will be about \$2,000, which can be met from the amount of \$12,000 for the construction of metric standards for distribution to the several States, included in the estimates for the next fiscal year.

Very respectfully,

GEO. S. BOUTWELL,
Secretary.

* The *mètre à traits* is the new standard form, being a plate of platinum with two microscopic lines (*traits*) marked thereon one meter apart; the old *mètre à bouts* is merely a rod of platinum one meter in length, with flat ends (*bouts*).—TRANSLATOR.

[Inclosure.]

Mr. Hilgard to Mr. Boutwell.

TREASURY DEPARTMENT,
OFFICE OF WEIGHTS AND MEASURES,
Washington, D. C., January 27, 1873.

Sir: With reference to your letter of the 21st instant (S. I. K.), making inquiry as to the number of the new metric standards about to be prepared by the International Metric Commission that will be required by the Government of the United States, I have the honor to state that a single copy of each standard will be sufficient, viz:

One mètre à trait (or metre defined by lines).
One mètre à bout (or metre defined by its ends).
One kilogramme.

The estimated expense of these standards will be about \$2,000, which can be met from the amount of \$12,000 for the construction of metric standards for distribution to the several States, included in the estimates for the next fiscal year.

Very respectfully,

J. E. HILGARD,
Assistant Superintendent of Weights and Measures.

The inclosures are herewith returned.

No. 5.

Marquis de Noailles to Mr. Fish.

[Translation.]

LEGATION OF FRANCE,
Washington, February 15, 1873. (Received February 18.)

The International Standard Commission adopted a series of resolutions at its last meeting, among them those contained in the inclosed note, the object of which is to secure the establishment at Paris of an International Bureau of Weights and Measures.

In accordance with the instructions contained in paragraph xxxvii the standing committee appointed by the standard commission has addressed the minister of agriculture and commerce for the purpose of securing through the mediation of the French Government the creation of an International Bureau of Weights and Measures on the basis stated by the commission itself.

The minister of agriculture and commerce has caused an approximate estimate to be made of the expense which would be necessary for the creation of the bureau, and also of the amount which would annually be required for its maintenance. It appears from the statements which have been furnished to him that, even if it should be found necessary to establish the proposed bureau in a special building, the cost of construction, together with that of an appropriate site, and of the necessary instruments, would probably not exceed 500,000 francs. The amount annually required for salaries, &c., would, it is thought, be from fifty to sixty thousand francs.

The French Government having been specially requested to bring the inclosed resolutions to the notice of the various countries interested, I have the honor to command them to your excellency's attention, begging you to be pleased to inform me whether the Government of the United States gives its adhesion to the principle therein involved. If so, there would doubtless be ground for the conclusion of a diplomatic convention to establish the conditions for the working of the international bureau, in conformity with the proposition of the commission, and to fix the share to be paid by each country of the expense of building and maintenance, a regular estimate of which expense would probably be prepared.

I shall be grateful to you, Mr. Secretary of State, if you will be pleased to inform me, as soon as possible, of the opinion entertained by the Federal Government of the proposition which I have hereby had the honor to submit to your excellency.

Be pleased to accept, &c.

MARQUIS DE NOAILLES.

[Inclosure.—Extract.—Translation.]

XXXVI. The international commission calls the attention of the governments interested to the great advantage which would accrue from the establishment at Paris of an International Bureau of Weights and Measures, on the following basis:

1. The establishment shall be international and shall be declared neutral.
2. Its seat shall be at Paris.

3. It shall be founded and supported at the common expense of all the countries which shall become parties to the treaty to be made, for the creation of the bureau by the countries interested.

4. The establishment shall be a dependency of the International Standard Commission, and shall be under the surveillance of the standing committee, which shall appoint its director.

5. The international bureau will have the following functions:

A.—To be at the disposal of the standing committee for the comparisons which are to serve as a basis for the verification of the new prototypes, of which the committee has charge.

B.—To preserve the international prototypes according to the orders of the international commission.

C.—To make periodical comparisons of the international prototypes with the national standards, and with the test standards, and also to compare the standard thermometers according to the rules established by the commission.

D.—To attend to the manufacture and verification of the standards which may hereafter be required by other countries.

E.—To compare the new metric prototypes with the other fundamental standards used in the different countries and in the sciences.

F.—To compare such standards and balances as may be sent for its inspection by governments or learned societies, or even by artists and men of science.

G.—The bureau shall perform all operations that may be required by the commission or its standing committee in the interest of meteorology and of the propagation of the metric system. (Commission, VII.)

XXXVII. The bureau of the international commission is instructed to address the French Government requesting it to communicate, through its diplomatic representatives, the recommendation of the commission in regard to the creation of an International Bureau of Weights and Measures to the governments of all the countries represented in the commission, and also requesting it to solicit these governments to conclude a treaty for the establishment, by general concurrence and with the least possible delay, of an International Bureau of Weights and Measures on the basis proposed by the commission. (Commission VII.)

No. 6.

Mr. Richardson to Mr. Fish.

TREASURY DEPARTMENT,
Washington, D. C., March 15, 1873. (Received March 17.)

SIR: I have the honor to acknowledge the receipt of a letter from the Department of State, dated the 22d of February last, inclosing a translation of a note from the French minister, and of a series of resolutions adopted by the International Standard Commission, relating to the establishment at Paris of an International Bureau of Weights and Measures, and desiring any suggestions upon the subject which this department might think proper to communicate.

In reply, I have respectfully to inform you that the translation of the papers referred to was, on the 25th ultimo, referred by this department to the Superintendent of Weights and Measures for the United States, and was by him returned on the 6th instant, with a letter (a copy of which is inclosed herewith) expressing his entire approval of the proposition, and suggesting that it be entertained by our government, certain conditions being carefully guarded.

The papers were subsequently, at the suggestion of the Superintendent of Weights and Measures, referred to Prof. Joseph Henry, president of the National Academy of Sciences, and have been received back from the latter with a letter, a copy of which is herewith inclosed, from which it appears that the subject will be considered by a committee of the academy above named.

When the report of that committee is received at this department a copy will be transmitted to the Department of State.

I am, &c.

WM. A. RICHARDSON.

No.8.

[Translation.]

*The Marquis de Noailles to Mr. Fish.*LEGATION OF FRANCE IN THE UNITED STATES,
Washington, December 22, 1873.

MR. SECRETARY OF STATE: In obedience to instructions which I have just received from the ministry of foreign affairs (direction of consulates and commercial affairs), I have the honor to transmit to your excellency two copies of the reports* of the sessions held by the permanent committee appointed to direct and superintend the execution of the resolutions of the international commission, concerning the comparison of the new metrical standards with each other, and the manufacture of apparatus to be used in making such comparisons. This permanent committee, which was appointed by the International Meter Commission, which sat in Paris in the months of September and October of last year, and was composed of members all belonging to different nationalities, met on the 1st of last month, in obedience to the call of its president, General Ibañez.

In addressing this communication to your excellency I am specially instructed to call the attention of the Federal Government to the proposition presented by General Ibañez during the session of October 30 (page 10 of the reports). This proposition, which was unanimously adopted by the committee, is as follows:

"The permanent committee, after having taken cognizance of the extended report addressed to it by the French section on the state of advancement of its labors, thinking that it is not proper that France alone should bear the expense of this work, which is for the general benefit, deems it to be its duty to endeavor to bring about the formation of a diplomatic conference, to take the necessary measures to enable the committee to make the numerous comparisons which it is incumbent upon it to make. Such a conference would insure, moreover, the preservation of the international standards and the making of such further comparisons of the meters and kilograms as might be desired by the various governments.

"The committee therefore resolves that its bureau shall address the French Government, with a view to securing the speedy convocation of such a conference at Paris."

The minister of commerce of France, to whom this proposition was directly transmitted (p. 24 of the reports), is disposed, so far as he is concerned, to give it his full adhesion. The French Government, however, thinks that it is but its duty to state the meaning, which, in its opinion, should be attached to the expression "diplomatic conference," which is used by the permanent committee. In the view of the French Government, it being the province of this conference to settle all questions touching the preservation of metric standards, and the method of execution of the comparisons which are to be made, it could only be composed of special delegates having full authority and competency to fulfill this mission; these delegates would be clothed with the necessary powers to prepare the draught of a convention to be ratified subsequently, according to diplomatic usages.

Under the limitation of this observance of pure form, the French Government will be glad to be informed whether the Government of the United States is disposed to comply with the wishes of the permanent committee, which the latter has requested it to bring to the notice of all the states represented in the International Meter Commission.

Be pleased to accept, Mr. Secretary of State, the assurance of my very high consideration.

MARQUIS DE NOAILLES.

No. 9.

*Mr. Davis to Mr. Richardson.*DEPARTMENT OF STATE,
Washington, January 3, 1874.

SIR: I have the honor to inclose herewith a copy in translation of a note of the 22d ultimo from the French minister, and its accompanying copy of a report of the international commission, concerning the comparison of the new metrical standards, and the manufacture of apparatus to be used in making such comparisons; and proposing

* Pamphlets, not translated.

that a conference composed of delegates from all the states represented in the purposes above indicated.

Requesting the return of the inclosed report, with an expression of your views regarding such conference,

I have the honor to be, sir, your obedient servant,

J. C. B. DAVIS.

HON. WM. A. RICHARDSON,
Secretary of the Treasury.

No. 10.

*Mr. Richardson to Mr. Fish.*TREASURY DEPARTMENT,
Washington, D. C. February 6, 1874. (Received February 7.)

SIR: I have the honor to acknowledge the receipt of the letter from the Department of State of the 3d ultimo, covering copy of a note from the French minister accompanying the report of the standing committee of the International Metric Commission, relative to comparison of new metric standards and apparatus for same, in which he proposes a conference at Paris of delegates from all states represented in the commission, and referring to former correspondence between the Secretary of State and this department on the subject, with request that any further suggestions or recommendations which it may be deemed advisable to make be communicated.

I have respectfully to inform you, in reply, that the report and accompanying papers, having been transmitted to the Superintendent of Weights and Measures, with instructions to take action agreeably to the request of the State Department above recited, have been returned to this department with a letter from Prof. J. E. Hilgard, Assistant Superintendent of Weights and Measures, of the 2d instant, herewith inclosed, in which he reviews the correspondence and action heretofore had in the matter, restates the main points of the subject, transmits copy of letter from Professor Peirce relative thereto, and submits a recommendation that two *mètres a trait* be asked for instead of one, as recommended in his letter of January 27, 1873.

I have to add that this department concurs in the recommendations and suggestions contained in the letter of Professor Hilgard, dated the 2d instant, above referred to, and I return the report as requested and transmit copies of letters of Professor Peirce, of March 6,* 1873; Professor Hilgard, of January 27, 1873, and this department, of January 30, 1873,† for the information of the Department of State.

I am, &c.,

WM. A. RICHARDSON.

[Inclosure.]

*Mr. Hilgard to Mr. Richardson.*TREASURY DEPARTMENT,
OFFICE OF UNITED STATES WEIGHTS AND MEASURES,
Washington, D. C., February 2, 1874.

SIR: In reply to your letters of January 9 and 14 (S. I. K.), transmitting communications from the Secretary of State, under date of January 3 and 13, relating to the construction of international metric standards, I have the honor, by direction of Professor Peirce, to submit the following statements, premising that in my quality as a member of the standing committee of the International Metric Commission, I am specially informed of the circumstances that lead to the inquiry of the Secretary of State.

1. The proposition for a diplomatic conference with the view to the establishment of an International Bureau of Weights and Measures at Paris, transmitted by the minister of France to the Department of State, under date of February 15, 1873, was favorably reported upon by the Superintendent of Weights and Measures (March 6, 1873) and by the National Academy of Sciences, whose report was adopted by the Treasury Department.

2. The proposition referred to did not, in the definite form in which it was submitted, meet with the assent of a sufficient number of states to warrant its being proceeded with. The standing committee, therefore, at its late session at Paris, in October, 1873, prepared the proposition now submitted, which leaves more freedom to the diplomatic conference, while it has the same objects in view, viz., the safe-keeping of

* See Document No. 6. † See Document No. 4.

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the international standards at the common charge, and their accessibility for future reference.

3. The present proposition being only a repetition of the previous one in a similar form, this office repeats its recommendation that it be agreed to by our government, and would particularly refer to the letter of Professor Peirce of March 6, 1873, a copy of which is appended, for the motives leading to that conclusion.

4. The necessity for special delegates, insisted upon by the French Government, is not very apparent. The purpose of the conference, as proposed by the standing committee, is to provide in general for the ways and means of securing the objects of the International Metric Commission, not to prescribe the details of comparison and safe-keeping, which were already determined on by the International Commission in October, 1872, whose standing committee had full power in regard to scientific details.

The American minister in Paris, provided with a memorandum, which the present writer would prepare for his information, would doubtless be able to deal understandingly with all questions that could properly be disposed of by the proposed conference. In that case we may presume, as heretofore (see my letter of July 3, 1873), that the diplomatic conference itself will cause no special expenditure.

5. As to subsequent expenditure, this office is already instructed by the Secretary of the Treasury to ask for an appropriation of \$12,000 for anticipated treaty obligations, which instruction will be acted on whenever the proposed arrangements have taken official form.

6. With reference to my letter dated January 27, 1873, a copy of which is asked for by the Department of State, and which specifies the standards desired for the use of this government, I take leave to change the recommendation of this office to the effect that *two mètres à trait* be asked for instead of *one*, for the reason that whenever it becomes desirable to transport our standard metre to Europe for comparison with the international standard, it will be necessary to retain an identical copy as a check against the accidents of transportation, and it would be utterly impracticable to manufacture a similar standard in this country.

All of which is respectfully submitted.

J. E. HILGARD,
Assistant Superintendent Weights and Measures.

No. 11.

[Extract.]

Professor Hilgard to Mr. Fish.

UNITED STATES COAST SURVEY OFFICE,
Washington, September 15, 1874. (Received September 16.)

SIR: I have the honor to inform you that a meeting of the standing committee of the International Metric Commission will be held at Paris, beginning October 6. As a member of that committee, it is my purpose to attend that meeting, having obtained the requisite permission from the Treasury Department, in whose employ I am as an assistant in the Coast Survey; but, holding my appointment as a commissioner (jointly with Professor Henry) from the Department of State, it appears proper that I should acquaint you with my proceedings in the premises.

The president of the commission, General Morin, in communicating to me the call for the meeting, takes occasion to express his regret that no reply has been received from this government to the proposition for a conference, which was communicated by the French envoy to the Department of State, under date of December 22, 1873.

Very respectfully, &c.,

J. E. HILGARD,
Delegate from the United States to the
International Metric Commission.

No. 12.

Mr. Cadwalader to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, September 23, 1874.

SIR: The department has received a letter from Professor Hilgard, suggesting that the proposition of the French Government for a diplomatic conference, so called, on

the metric question, should be replied to. The Treasury Department was informed of that proposition by the letter of the Department of State of the 3d of January last.

There is a disposition to adopt the suggestions of Professor Hilgard, and to accept the proposition adverted to, but before deciding upon the matter it is desirable to know if the Treasury Department is willing to provide for any expense which the diplomatic conference may occasion.

* * * * *

JOHN L. CADWALADER,
Acting Secretary.

No. 13.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
Washington, D. C., October 24, 1874. (Received October 26.)

SIR: I have the honor to acknowledge the receipt of the letter of the Hon. John S. Cadwalader, Acting Secretary of State, dated the 23d ultimo, in which he states that Professor Hilgard has suggested that the proposition of the French Government for a diplomatic conference on the metric question should be replied to, and adds that the Department of State is disposed to adopt the proposition referred to, but before deciding upon the matter desires to know if the Treasury Department is willing to provide for any expense which the diplomatic conference may occasion.

I have respectfully to state in reply that the subject having been referred to the Superintendent of Weights and Measures, a reply has been received from that officer, dated the 19th instant, a copy of which is inclosed herewith, referring to the international character of the proposed bureau, and to the fact that access to it for any comparisons desired by scientific bodies in this country would necessarily be made through the State Department, and suggesting that final acceptance of the proposal pending from the French Government can have effect only by the action of Congress in voting a sum estimated by the Department of State as the just contribution of the United States toward the establishment of the international bureau contemplated.

I have the honor to say that, having given the subject full consideration, this department concur in the views of the Superintendent of Weights and Measures.

I am, &c.,

B. H. BRISTOW.

[Inclosure.]

Mr. Patterson to Mr. Bristow.

UNITED STATES COAST SURVEY OFFICE,
Washington, October 19, 1874.

SIR: I have the honor to state, after review of correspondence which accompanied the department letter of September 30, that the proposal of the French Government to establish at Paris an International Bureau of Weights and Measures has therein the expressed concurrence of the late Superintendent of the United States Weights and Measures and recommendation from our National Academy of Sciences that the Government of the United States should co-operate in establishing such a bureau.

For the purposes to be served by the proposed establishment, the report made by the committee of the National Academy of Sciences, and in which I fully concur, shows that in the bureau no branch of service in this government would have special relations. The bureau, national in its conception, would be international in its character. Access to it for any comparisons desired by scientific bodies in this country, by boards of survey, State or national, offices of weights and measures either in our individual States or in the United States, would necessarily be through the State Department in Washington, to which, if need be, would come, through the several departments, applications from the Engineer Bureau of the Army, from the General Land Office, or from the Mint.

If the expense which the diplomatic conference may occasion, mention of which is made in the letter of September 23d, from the Department of State, refers to the sum mentioned by the French minister in the proposal which he addressed to the honorable Secretary of State under date of February 15, 1873, as the estimated aggregate contribution of the co-operating nations, useful in founding and maintaining the proposed international bureau, it is respectfully submitted that final acceptance by

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our government of the proposal pending from the French Government can have effect only by the action of Congress in voting a sum estimated by the honorable Secretary of State as the just contribution of the United States toward the establishment at Paris of an International Bureau of Weights and Measures.

I further respectfully suggest that it would not be reasonable to expect the Secretary of the Treasury to submit to Congress, nor the Superintendent of the Standard Weights and Measures to estimate for, an appropriation which must necessarily be expended through the Department of State, and over which neither the Secretary of the Treasury nor the Superintendent of the Standard Weights and Measures would have any control.

The correspondence, as requested, is herewith returned.

Very respectfully, &c.,

C. P. PATTERSON.

No. 14.

Mr. Cadwalader to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, November 4, 1874.

SIR: I have the honor to acknowledge the receipt of your communication of the 24th ultimo, in reply to one from this Department of the 23d of September last, in which inquiry was made as to whether the Treasury Department was willing to provide for any expenses that may be occasioned by the diplomatic conference, proposed to be held at Paris, for the purpose of framing a conventional arrangement looking to the establishment of an International Bureau of Weights and Measures at Paris, the functions of which bureau would be the manufacture and comparison of international metric standards of measurement and weight, &c.

Mr. Patterson, the Superintendent of the Coast Survey and of Weights and Measures, to whom you referred the letter of this department of the 23d of September, in his letter to you of the 19th ultimo, a copy of which you transmit, assumes that the inquiry of this department related to the expenses which would be involved in the part to be borne by the United States in the creation and maintenance of the proposed international bureau should it become a party to the arrangement.

This was not the case, however; for this department regarded that question as settled, or as one in course of settlement, upon the basis indicated in the statement made by Mr. J. E. Hilgard, Assistant Superintendent of Weights and Measures, in his letter of February 2, 1874,* a copy of which was transmitted by the Secretary of the Treasury, who concurred therein, to this department, with a communication of February 6, 1874. Mr. Hilgard's statement is as follows:

"As to subsequent expenditure, this office is already instructed by the Secretary of the Treasury to ask for an appropriation of \$12,000 for anticipated treaty obligations, which instruction will be acted on whenever the proposed arrangements have taken official form."

The department still regards the mode thus indicated as the proper one of providing the necessary means for defraying the share of the expenses of the proposed bureau which it would devolve upon the United States to meet.

The object of the inquiry, submitted in my letter of September 23, was to ascertain whether the Treasury Department was willing to provide for any expense attending the diplomatic conference; but as, upon a further examination of the same letter of Mr. Hilgard, I find the suggestion approved by the Secretary of the Treasury, that the diplomatic representative of the United States, furnished with proper data, to be prepared by Mr. Hilgard, can represent the United States in the conference in such a way that any expense attending his performance of that duty would be insignificant, that question may be regarded as disposed of, provided your department should still recommend that the diplomatic representative of the United States should represent this government, being furnished with proper information.

This department, considering the undertaking in the light thrown upon it by the exposition of its benefits contained in the communications received from your department, is disposed to agree in the conclusions arrived at, and is ready to forward those views expressed by your department in such way as you may request.

It is proper, however, to state that the action of this department is deemed to be that of an intermediary merely in furtherance of a matter not properly belonging to it, but the correspondence upon which, as occurs in similar matters, must be conducted through this department.

It has never regarded it as at all its province to present the subject to Congress, or to request an appropriation therefor, but should expect your department, at the ter-

* See Document No. 10.

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mination of the diplomatic conference, should one take place, to pursue the course indicated in the letter of Professor Hilgard of February 6, 1874, as above indicated, or such other course as might appear proper to yourself.

Believing that some misapprehension has existed on this matter, I will thank you for an expression of your views in the light of the explanation herein contained, looking to an answer from this department to the letter of the French minister as to the proposed conference.

I have, &c.,

JOHN L. CADWALADER,
Acting Secretary.

No. 15.

Mr. Bartholdi to Mr. Fish.

[Translation.]

LEGATION OF FRANCE IN THE UNITED STATES,
Washington, November 23, 1874. (Received November 27.)

MR. SECRETARY OF STATE: The Marquis de Noailles had the honor to communicate to your excellency, on the 22d of December, 1873, a resolution of the standing committee of the International Metre Commission, the object of which was to bring about a diplomatic conference which should take the necessary measures to enable the committee to make the numerous verifications which it has been instructed to make. It would, moreover, be the duty of this conference to provide for the preservation of international standards, and for the making hereafter of such comparisons of metres and kilogrammes as might be desired by the various governments.

This proposition of the standing committee, which has been transmitted to all the countries represented in the International Metre Commission, has obtained the adhesion of a certain number of them, viz., Germany, Belgium, Brazil, Colombia, Denmark, Spain, The Netherlands, Russia, Sweden and Norway, and Switzerland.

Germany has given its consent, with only one proviso, viz., that the conference shall "fix conditions of strict neutrality for the organization of the custody, the control, and the use of the common standards by a permanent scientific institution."

Russia, while declaring itself ready to take part in the conference, expresses the wish that the scientific questions may not be the only ones submitted to it but that the utmost latitude may be granted to it for the examination of everything connected with the task which has been confided to the International Metre Commission.

These provisos are in nowise at variance with the desire expressed by the standing committee, and there will doubtless be no objection made to them by any of the governments.

England is the only power which has thought proper to decline the proposition of the standing committee. She has done so on the ground that the interest which she might have in adopting the metric system and in recognizing an international standard would not be sufficiently direct and immediate for her to feel authorized to ask Parliament for a special appropriation.

The other countries, that is to say, Austria, Hungary, the United States, Italy, Portugal, Turkey, Greece, and most of the South American governments, have not yet communicated their replies.

Such, Mr. Secretary of State, was the state of the question when, during the session of last month, the standing committee adopted and communicated to the French Government the following resolution:

"In view of the large number of favorable replies from the countries interested in the success of the plan proposed last year to the French government for a diplomatic conference which should meet for the purpose of enabling the committee to perform all the labors intrusted to it, as well as of providing for the preservation of the international standards and for the comparisons to be made in future, the committee instructs its bureau to address the French Government, requesting it to convoke the diplomatic conference with as little delay as possible."

The French Government cannot do otherwise than comply with this request. It seems to it important no longer to defer the convoking of the conference, the object of which is to conclude a convention which may secure an international organization to the labors of the metre commission, to the custody of the standards, to their preservation, and to their ulterior use. It has, therefore, been decided, Mr. Secretary of State, that this invitation should be officially addressed, not only to the governments which have already signified their adhesion, but also to those which have not yet communicated their replies to the proposition of the standing committee, in the conviction that these latter will not hesitate to take part in deliberations of such high importance and of such universal interest.

The object of this conference being to conclude a diplomatic convention touching matters most of which will require technical knowledge, it seems that it ought to be conducted in the same manner as was the international telegraphic conference that was held at Paris in 1865.

Each government would then furnish its diplomatic representative accredited in France with the full powers necessary for the signing of the convention, appointing at the same time as adjuncts, if he should deem this desirable, one or more special delegates, in case the conference should think proper, according to the plan adopted in 1865, to confide to a commission composed in great part of such delegates the task of preparing the draught of a convention, which should afterward be submitted to its approval.

Not doubting that this mode of proceeding, which seems the one best calculated to secure a satisfactory result, will be approved by all the countries, the French Government has already selected Mr. Dumas, perpetual secretary of the Academy of Sciences, formerly a minister, and General Morin, director of the *Conservatoire des Arts et Métiers*, to represent it as special delegates to the conference.

As to the time for the meeting of the conference, the French Government would suggest Monday, the 1st of February next, this delay seeming strictly necessary in order to enable all the governments which have taken part in the International Metre Commission to receive their notifications and to make their arrangements.

I should be happy, Mr. Secretary of State, to be able to announce to my government that the Government of the United States has favorably received this proposition, and in that case I should be grateful to your excellency if you would be pleased to communicate to me the names of the special delegates whom it might think proper to designate as assistants to its diplomatic representative at Paris.

Be pleased to accept, &c.,

A. BARTHOLDI.

No. 16.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, November 30, 1874.

SIR: Referring to previous correspondence, and particularly to my letter of the 4th instant, in reference to the diplomatic conference proposed by the standing committee of the International Metre Commission, I have now the honor to inclose you a copy, in translation, of a note from the representative of France, bearing date the 23d November, upon the same question.

You will perceive from this communication that the French Government has named certain special delegates, and has suggested the 1st of February as the date for the meeting of the conference; and information is requested from this department whether this government will take part therein, and whether special delegates will be named for that purpose. I will thank you to inform me of the conclusions of your department in reference to this question, that I may be enabled to answer these inquiries.

In the prior communications on this question, I had the honor to refer you to the conclusions to which your department had arrived in reference to the expense to be incurred by the permanent establishment of the proposed "commission," and of the views of this department in relation to these expenses of the diplomatic conference in case special delegates were appointed.

I have, &c.,

HAMILTON FISH.

No. 17.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
January 9, 1875. (Received January 11.)

SIR: Respectfully referring to the communication from the honorable the Secretary of State, dated the 30th November last, relative to the proposed diplomatic conference of the International Metric Commission, and to the copy (in translation) of a note from the representative of France upon the same question, transmitted with a subsequent letter from the Department of State, I have the honor to inform you that copies of the communications, and the note in translation above referred to, were transmitted to the Superintendent of Weights and Measures for his consideration, with letters of this de-

partment of the 4th and 8th ultimo, and a reply has been received from that officer, dated the 8th instant (a copy of which I have the honor to transmit herewith), in which he makes certain suggestions as to the future action of the Government of the United States relative to the matters alluded to and the participation of the Department of State and this department therein respectively, which have the approval of this department if satisfactory to the Department of State.

I have, &c.,

B. H. BRISTOW.

[Inlosure.]

Mr. Patterson to Mr. Bristow.

UNITED STATES COAST SURVEY OFFICE,
Washington, January 8, 1875.

SIR: I have the honor to submit, in compliance with a request in the department letter of December 4, 1874, my views in regard to the diplomatic conference proposed by the standing committee of the International Metric Commission, which conference is the subject of a communication which was addressed to the Treasury Department by the honorable Secretary of State, under date of November 30, 1874.

1. That the Government of the United States should take part in the diplomatic conference proposed to be held on the 1st of February proximo, for the purpose indicated in the dispatch of the French minister of date November 23, 1874.

2. That it is not necessary to send a special delegate, if the Department of State will request the United States minister at Paris to represent our government in the conference, the subject to be treated being of an administrative and not of a technical character. Moreover, no means are available to pay the expenses of a special delegate. It is understood that the members on the part of the United States, of the International Metric Commission, Professor Henry and Mr. Hilgard, are preparing, and will furnish for the State Department without delay, a minute for the information of the American minister at Paris.

3. That expenditures arising from the participation of the United States in the construction of the new international metric standards should be provided for by appropriation to be procured by the Treasury Department, as likewise those that may arise from the participation of this government in the erection of an international Bureau of Standard Weights and Measures at Paris. I would, in this connection, refer notice to the department letter of July, 1872, authorizing the Superintendent of United States Weights and Measures to insert into estimates for the deficiency bill the sum of \$12,000 for (anticipated) treaty obligations on that account.

4. That if such establishment is founded by the co-operation of leading civilized nations, and the United States takes part in it, the most convenient way of providing for the annual contribution of our country to its maintenance would probably be to have the Department of State include the amount in the budget of that department as a treaty obligation.

Very, &c.,

C. P. PATTERSON.

No. 18.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, January 13, 1875.

SIR: I have the honor to acknowledge the receipt of your letter of the 9th instant (which reached this department on the 11th), in reference to the proposed diplomatic conference of the International Metric Committee, and with which you transmit a copy of a letter addressed to you by the Superintendent of Weights and Measures, containing his recommendations as to the proper course to be pursued, in which you state that you concur.

Your letter recommends that the Government of the United States should take part in the conference, and should be represented by Mr. Washburne, and that the necessary data and information be furnished by Professor Henry and Mr. Hilgard.

As understood by me, it assumes that all future expenses arising from the conference shall be provided by the Treasury Department, but suggests that, should a treaty be entered into and the government made liable thereby for a certain sum as an annual contribution, such amount might properly be included in the estimates of the Department of State.

In reply, I have the honor to say that Mr. Washburne will be instructed to represent this government at the conference upon receipt of the necessary information and instructions for his guidance, as suggested, but that it will be expected that such incidental expenses as may be incurred by him shall be paid by the Treasury when drawn for.

Should further steps be necessary, arising from this conference, or should further expenditure be required, this department, considering the whole question as properly under your department, will leave all such matters to the Treasury Department.

Should a treaty be made, and an annual expense incurred hereafter as a treaty obligation, it may be a matter of future consideration as to how such annual amount may be best provided.

I beg, however, to remind you that, as your letter of January 9 is the reply to my communication of the 30th November, and as the conference is fixed for the 1st February, according to the note of the French minister, no time should be lost in replying to the invitation so extended, and in instructing Mr. Washburne.

The invitation will be accepted by note to the French minister, should you so request on receipt hereof; and any information furnished this department will be forwarded to Mr. Washburne, for which there seems, even now, to be barely sufficient time.

I have, &c.,

HAMILTON FISH.

No. 19.

Messrs. Henry and Hilgard to Mr. Fish.

WASHINGTON, January 13, 1875. (Received January 14.)

SIR: The undersigned, members on the part of the United States of the International Metric Commission, beg leave to submit the subjoined memorandum for the use of the representative designated by this government to take part in the diplomatic conference to assemble in Paris on February 1, for the purpose of taking measures to enable the standing committee of the commission to make the numerous verifications and comparisons with which it has been charged, and also of providing means for the preservation of the international standard, and for such future comparisons of the same with the metric and other national standards of the participating governments as may be from time to time desired.

Very, &c.,

JOSEPH HENRY.
J. E. HILGARD.

Memorandum of Messrs. Henry and Hilgard.

The objects of the conference are stated in the communication of the French minister. They are:

1. To provide the means for the final verification and comparison of the new standards, which have been constructed under the care of the French section of the commission. This will doubtless be done by an allotment of the expense among the participating governments.

2. To provide for the safe-keeping of the international standards and apparatus, and for their future use. To this end the commission have proposed the creation of an "International Bureau of Weights and Measures," the organization of which is sketched in their resolutions Nos. 36, 37. (See volume of proceedings, 1872.) This plan has met the approval of the United States Treasury Department, having charge of standard weights and measures, and of a committee of the National Academy of Sciences specially appointed to report on the subject. (See their report, which is appended; also letters from the office of weights and measures to Treasury Department, dated March 6, 1873, and February 6, 1874.)

The material requisites of such an establishment are, that a building specially adapted for the purpose should be erected in some locality free from tremors caused by railroad traffic or factories, and that it should be near some large city, where the assistance of skilled mechanicians can be obtained. The vicinity of Paris is in these respects acceptable.

The plans for the building and their execution should be under the control of the "comité permanent" of the International Metric Commission.

3. If the erection of such a building be determined on, the execution of the comparisons under section 1 would better be delayed until they can be performed under the favorable conditions afforded by that establishment. It is not probable that any existing building could be made available without considerable and expensive alterations.

4. The question will arise whether the proposed establishment should be provided

with a competent permanent *personnel* or whether it should, after its use by the commission, lapse into a mere *depot* or depository of the standards and apparatus, to be used by the interested parties as occasion might arise. We are clearly of opinion that it should at once be placed, and afterwards remain, in the charge of a warden, who should be a man of recognized scientific ability, and of special technical experience, with such assistance as may be necessary for the safekeeping of the building. This appears to be the minimum of personal establishment that the nature of the case admits of. Its subsequent enlargement by the addition of assistants and mechanicians must depend upon the development of the activity of the institution.

5. An item of \$12,000 for anticipated treaty obligations for the objects in question has been included by the Treasury Department in the estimates for the deficiency bill for the current fiscal year.

JOSEPH HENRY.
J. E. HILGARD.

No. 20.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
Washington, D. C., January 16, 1875. (Received January 18.)

SIR: I have the honor to acknowledge the receipt of your letter of the 13th instant, in reference to the proposed diplomatic conference of the International Metric Commission.

In reply, I have the honor to request that, as suggested by you, the invitation of the French minister for the United States to participate in the diplomatic conference referred to, be accepted by the Department of State in the manner named; and that the United States minister at Paris, Mr. Washburne, be instructed to represent this government at the February conference, the memorandum for his information and guidance having been, as I am informed, already furnished the Department of State by the United States commissioner connected with this work.

I have also respectfully to state that the Treasury Department will undertake to defray such incidental expenses as Mr. Washburne may incur in representing our government at the diplomatic conference, in accordance with the suggestion contained in your letter referred to above.

I have, &c.,

B. H. BRISTOW.

No. 21.

Mr. Fish to Mr. Bartholdi.

DEPARTMENT OF STATE,
Washington, January 18, 1875.

SIR: You have already been informed that I referred to the Treasury Department the communication of the 22d of December, 1873, addressed to this department by the Marquis de Noailles, and that from yourself of the 23d of November, 1874, relative to a diplomatic conference to be held at Paris on the 1st of February next, at the recommendation of the permanent committee of the International Metric Commission, to which the Government of the United States is invited to send delegates. I have now the honor to inform you that the Secretary of the Treasury having reported favorably upon the subject, this government, actuated by a desire to take part in the deliberations contemplated by this conference, as set forth in your note of the 23d of November, accepts the invitation so conveyed, and that the President has designated Mr. E. B. Washburne, the envoy extraordinary and minister plenipotentiary of the United States accredited to your government, as the delegate to represent the United States in the diplomatic conference, to whom the necessary powers and instructions will be transmitted for that purpose by the next mail.

This department has been informed by the Department of the Treasury, to which the subject appropriately belongs, that it is not possible to send special delegates as assistants to the minister of the United States; but information will be furnished him which it is hoped will obviate that necessity. It is proper that I should add that, as the representative of the United States in Paris has not the advantage of the assistance of skilled experts in relation to this matter, he will be instructed to report to this government, for approval, the final conclusions of this conference before entering into any positive engagement on the part of this government; and, further, because legis-

lation may be hereafter required before the results of the conference can be finally adopted by this government or a convention agreed upon for such purpose.

I regret the delay which has occurred in communicating to you this acceptance of the invitation, and which has been occasioned by circumstances not within control of this department.

Accept, &c.,

HAMILTON FISH.

No. 22.

Mr. Fish to Mr. Washburne.

No. 670.]

DEPARTMENT OF STATE,
Washington, January 19, 1875.

SIR: I inclose herewith a copy of correspondence which has taken place between the French legation and this department, and between this department and that of the Treasury, upon the subject of a diplomatic conference to be held at Paris on the 1st proximo, to which, at the instance of the permanent committee of the International Metre Commission, this and other governments have been invited by that of France to appoint delegates.

The President having designated you as the delegate to represent the United States in the proposed conference, I inclose a special power authorizing you to participate therein.

Your attention is specially directed to the following extract from my note of yesterday to Mr. Bartholdi, the minister of France, a full copy of which is inclosed herewith:

"This department has been informed by the Department of the Treasury, to which the subject appropriately belongs, that it is not possible to send special delegates as assistants to the minister of the United States; but information will be furnished him, which it is hoped will obviate that necessity. It is proper that I should add that as the representative of the United States in Paris has not the advantage of the assistance of skilled experts in relation to this matter, he will be instructed to report to this government for approval the final conclusions of this conference before entering into any definite engagement on the part of this government; and, further, because legislation may be hereafter required before the results of the conference can be finally adopted by this government, or a convention finally agreed upon for such purpose."

The invitation of the French government has been accepted, at the request of the Department of the Treasury, and it seems proper that the results of the conference should be made known through this department to that of the Treasury.

It is also thought probable that should this conference decide to permanently establish a bureau at Paris, some legislation upon the question may become necessary on the part of this government to enable it to take part therein.

In your proceedings as the delegate of the United States in the conference, you will therefore act subject to the conditions and limitations defined in the foregoing extract, and will, of course, make this fact fully understood by your colleagues; and in any protocol or form of agreement which you may sign, you will see that, so far as it concerns this government, or your signature on its behalf, special reservation is made in accordance therewith, and with the terms of your special power from the President.

You will perceive by the correspondence with the Treasury that that department has agreed to furnish you with all necessary instructions and information for your guidance, and the inclosure B* has been furnished as supplying such information in connection with the correspondence also inclosed.

For information, therefore, as to the general purposes and scope of the measures which the conference is to consider and negotiate upon, you are referred to the inclosed copy of a memorandum prepared by Professors Joseph Henry and J. E. Hilgard, members of the International Metric Commission (inclosure B), and to the copies in translation of the notes from the Marquis de Noailles and Mr. Bartholdi to this department under the respective dates of December 22, 1873, and November 23, 1874 (inclosures C and D).

You are also referred to the accompanying copies of letters from Professor Hilgard to the Secretary of the Treasury, of the respective dates of March 6, 1873, † and February 2, 1874, ‡ as containing useful information as to the origin of the proposed conference and valuable suggestions upon the subject.

You will also learn by the letter from the Treasury Department of January 16th instant that such incidental expenses as may be properly incurred by you in participating in the deliberations of the conference will be paid when drawn for upon the Treasury, which draft should be accompanied by the usual vouchers.

I am, &c.,

HAMILTON FISH.

*See Document No. 19.

† See Document No. 6.

‡ See Document No. 10.

No. 23.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, January 22, 1875.

SIR: I have the honor to acknowledge the receipt of your letter of the 16th instant, which reached this department on the 18th, relative to the diplomatic conference proposed to be held at Paris on the 1st proximo, and to inform you in reply that, in compliance with your suggestion, a note was, on the 18th instant, addressed to Mr. Bartholdi, the minister of France here, accepting the invitation, and that instructions have been sent in duplicate, by different mails, to Mr. Washburne, directing him to represent the United States at the conference.

The memorandum prepared for Mr. Washburne's information and guidance by Professors Henry and Hilgard was duly received at this department on the 14th instant, and a copy of it and of the correspondence necessary for an understanding of the subject was transmitted with the instructions referred to.

Mr. Washburne was advised that his proceedings in the conference, or any protocols or engagements which he might sign, would be subject to subsequent approval; and he was instructed to make this fact known to his colleagues in the conference.

I have, &c.,

HAMILTON FISH.

No. 24.

Mr. Washburne to Mr. Fish.

No. 1094.]

LEGATION OF THE UNITED STATES,
Paris, February 2, 1875. (Received Feb. 19, 1875.)

SIR: I have the honor to acknowledge the receipt of your dispatch No. 670, under date of the 19th ultimo, with the inclosures, among which is the commission of the President conferring upon me authority to act in the name of the United States as their representative at the international conference which was to have been held in Paris on the first of this month. I sent at once to find out in regard to the meeting of the conference, and ascertained that it was postponed until the first day of March. I have officially advised the Duc Decazes of my appointment, and notified him that I would be ready to participate in the proceedings of the conference as the representative of the United States.

I am glad of this delay which takes place in the meeting of this conference, as it will enable me to post myself up on the subject, and, if necessary, obtain the assistance of some person who understands the subject more thoroughly than I can pretend to.

I have the honor to be, very respectfully, your obedient servant,

E. B. WASHBURN.

HON. HAMILTON FISH,
Secretary of State.

No. 25.

Mr. Bartholdi to Mr. Fish.

[Translation.]

LEGATION OF FRANCE IN THE UNITED STATES,
Washington, February 20, 1875.

MR. SECRETARY OF STATE: I have the honor to inform your excellency that the first meeting of the Diplomatic Metric Conference, which was to have been held on the 1st instant, has been postponed, in compliance with the request of Russia, until March 1st.

My government instructs me to bring this decision to the knowledge of your excellency, in order that you may be enabled to take the necessary steps in case you shall think proper to appoint an adjutant delegate to assist Mr. Washburne, who has already been appointed to represent the Government of the United States at the conference.

Be pleased to accept, Mr. Secretary of State, the assurances of my very high consideration.

A. BARTHOLDI.

No. 26.

Mr. Washburne to Mr. Fish.

No. 1110.]

LEGATION OF THE UNITED STATES,
Paris, March 1, 1875. (Received March 22.)

SIR: I have the honor to inform you that the Diplomatic Metrical Conference met to-day, at 1 o'clock, at the Ministry of Foreign Affairs. I beg leave to inclose you here-with a list of the diplomatic members of said conference, including also the delegates of all the States which up to the present date have acceded to the request to take part therein.

Count Apponyi, the Austrian ambassador, being the senior diplomatic representative present, called the conference to order, and nominated the Duke Decazes as president. On taking the chair, the duke expressed his thanks for the honor conferred upon him, and briefly explained the objects of the conference. An organization having thus been effected, Dr. Kern, the minister from Switzerland, proposed that a committee be appointed, composed of all the delegates who appeared in the conference, to which should be submitted the subjects before the conference, with instructions to examine them and report thereon at a subsequent meeting.

Chevalier Nigra inquired what was the status of the permanent committee, whether it still existed, and, if so, what were its functions; and he stated, as did also Dr. Kern, that he had instructions from his government to insist upon putting one member on that committee from each state represented in the conference in case it should be reorganized.

Explanations were made by Duke Decazes, Dr. Kern, General Ibafiez, and General Morin, from which it appeared that the permanent committee had virtually ceased to exist, and that all the powers which had belonged to it had lapsed and belonged to the conference.

Dr. Kern's proposition was then taken up and adopted with unanimity. Upon his suggestion, Mr. Dumas, the celebrated chemist, was made chairman of the committee. Whereupon the conference adjourned, subject to the call of the president, whenever the committee should be ready to report.

Availing myself of the authority given by the department to employ assistance in the deliberations upon these subjects of special investigation, I have associated with myself for this purpose Henry Vignaud, whose ample qualifications for anything he undertakes are so well known to the department.

I have the honor to be, very respectfully, your obedient servant,
E. B. WASHBURN.

Hon. HAMILTON FISH,
Secretary of State.

[Inclosure.]

Diplomatic Metrical Conference.

GERMANY.

Plenipotentiary.—His Highness Prince Hohenlohe-Schillingsfürst, Ambassador Extraordinary and Plenipotentiary.

Delegate.—Dr. Foerster, Director of the Bureau of Weights and Measures, Professor and Director of the Berlin Observatory.

ARGENTINE REPUBLIC.

Plenipotentiary.—Mr. Balcarce, Envoy Extraordinary and Minister Plenipotentiary.

AUSTRIA-HUNGARY.

Plenipotentiary.—His Excellency Count Apponyi, Ambassador Extraordinary.

Delegate.—Dr. J. Herr, Professor of Geodesy and Astronomy at the Polytechnic School of Vienna, Director of Weights and Measures.

BELGIUM.

Plenipotentiary.—Baron Beyens, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Stas, Member of the Royal Academy of Belgium.

BRAZIL.

Plenipotentiary.—The Viscount d'Itajuba, Envoy Extraordinary and Minister Plenipotentiary.

DENMARK.

Plenipotentiary.—Count von Moltke-Hvitfeldt, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Holten, Professor of Physics at the University of Copenhagen.

SPAIN.

Plenipotentiary.—General Ibafiez, Director of the Geographical Institute of Spain, and Member of the Academy of Sciences.

UNITED STATES OF AMERICA.

Plenipotentiary.—Mr. E. B. Washburn, Envoy Extraordinary and Minister Plenipotentiary.

FRANCE.

Plenipotentiaries.—His Excellency the Duke Decazes, Minister of Foreign Affairs, and His Excellency M. Grivart, Minister of Agriculture and Commerce.

Delegates.—Dumas, ex-Minister, Perpetual Secretary of the Academy of Sciences; General Morin, Member of the Institute and Director of the Conservatoire des Arts et Métiers; Péligot, Member of the Institute Dumonsteir de Frétilly, Director of Internal Commerce at the Ministry of Agriculture and Commerce, and Jägerschmidt, Assistant Director at the Ministry of Foreign Affairs.

GREECE.

Plenipotentiary.—Mr. Coundonioti, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Delyanni, First Secretary of Legation.

ITALY.

Plenipotentiary.—Chevalier Nigra, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Govi, Professor of Physics at the University of Turin.

NETHERLANDS.

Plenipotentiary.—Baron Zuylen Van Nyerelt, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Stamkert, Professor at the Polytechnic School of Delft, and Member of the Academy of Sciences, and Bosscha, Inspector of Secondary Instruction at the Hague, and Member of the Academy of Sciences.

PERU.

Plenipotentiary.—Mr. Pedro Galvez, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Francisco de Rivero, formerly Minister Plenipotentiary.

PORTUGAL.

Plenipotentiary.—Mr. José da Silva Mendes Leal, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—General Morin, Member of the Institute.

RUSSIA.

Plenipotentiary.—Mr. Okouneff, Councilor of State and Counsel to the Legation.

Delegate.—H. Wild, Member of the Academy of Sciences at St. Petersburg, and Director of the Physical Observatory.

SWEDEN AND NORWAY.

Plenipotentiary.—Baron Adelsward, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Baron Wrede, Lieutenant-General and Member of the Academy of Sciences at Stockholm.

SWITZERLAND.

Plenipotentiary.—Mr. Kern, Envoy Extraordinary and Minister Plenipotentiary.

Delegate.—Dr. Hirsh, Director of the Observatory at Neufchâtel.

TURKEY.

Plenipotentiary.—His Excellency Ali Pasha, Ambassador Extraordinary and Plenipotentiary.

Delegate.—Husny Bey, Chief of Staff and Military Attaché of the Ottoman Embassy

VENEZUELA.

Plenipotentiary.—Eliseo Acosta.

No. 27.

Mr. Washburne to Mr. Fish.

No. 1116.]

LEGATION OF THE UNITED STATES,
Paris, March 15, 1875. (Received April 2.)

SIR: I have the honor to inclose herewith a copy of a communication, which is in the nature of a report, by Mr. Henry Vignaud, who acted for me in the deliberations of the special commission of delegates appointed by the Metrical Diplomatic Conference. The document explains itself, and will be especially interesting to the Treasury Department, to which his suggestions are respectfully commended.

I have the honor to be, very respectfully, your obedient servant,

E. B. WASHBURN.

Hon. HAMILTON FISH,
Secretary of State.

[Inclosure.]

Mr. Vignaud to Mr. Washburne.

PARIS, March 14, 1875.

SIR: Since you have intrusted to me the delicate duty of taking charge of the interests of the United States in the commission of delegates appointed by the metrical conference at its first meeting, I have given the matter all my attention.

After different meetings our labors took a definite shape, and on the 9th two projects were read, providing each for the organization of the international establishment upon which we have been commissioned to report. They were ordered to be printed, and on the 12th the general discussion began. I inclose copy of each.*

Project No. 1 was brought up by General Ibañez, Dr. Foerster, and Mr. Hirsch. After consulting with you, I have signed it in behalf of the United States. Besides our approval, it has now the sanction of Italy, Germany, Austria, Russia, Spain, Belgium and Switzerland. I think I can add safely that it has also the good-will of the president of our commission, Mr. Dumas, who is the real representative of France in the conference so far as scientific matters are concerned. Its general tendency is in strict conformity with your instructions, particularly with the memorandum of Profs. Joseph Henry and J. E. Hilgard, of January 13, and also with the contents of a private note addressed to you by the latter on January 22, for the purpose of approving certain suggestions made by General Ibañez, president of the permanent committee.

Project No. 2 was prepared by Professor Bosscha.

At the suggestion of Mr. Dumas, a sub-committee has been appointed to endeavor to conciliate the two projects, but it is likely that the principal features of project No. 1 will be retained.

You will perceive that art. 3 of that project provides for the creation of an international commission, to be composed of the twelve members of the permanent committee, with the addition of the two members who received the next greatest number of votes at the election of that committee.

This is intended to bring in the Swiss and Italian delegates, Messrs. Hirsch and Covi. As on this point the authors of project No. 2 agree with those of the other, there can be no doubt that whatever solution we may come to, Mr. Hilgard will be a member of the commission. I think I may be allowed to say that it is through my exertions that this result has been obtained.

You will perceive also that by art. 6 the members of the proposed commission are allowed to vote by correspondence. This is intended chiefly to enable Mr. Hilgard to take part in the proceedings of the commission. Therefore it is a matter of much importance that Mr. Hilgard should be advised of the day upon which the commission, if approved by the conference, will elect its bureau and proceed to the organization of the institute provided for in art. 12.

* Not translated.

To reach this end I take the liberty to suggest the propriety of advising the government that you will telegraph that information in case it cannot be conveyed in time by mail.

Of course, this action of the proposed commission can only take place after the conference will have approved it, and it will be subject, together with the proceedings of the conference itself, to the sanction of our government, but it is nevertheless important to enable Mr. Hilgard to take part in that action; for if we abstain, the approval of the government might find the commission organized without our participation.

I am, with much respect, your most obedient servant,

HENRI VIGNAUD.

Hon. E. B. WASHBURN,
United States Minister.

No. 28.

Mr. Washburne to Mr. Fish.

No. 1124.]

LEGATION OF THE UNITED STATES,
Paris, March 26, 1875. (Received April 7.)

SIR: I have the honor to inclose herewith a copy of a second communication in the nature of a report by Mr. Henry Vignaud, in relation to the deliberations of the special commission of delegates appointed by the Metrical Diplomatic Conference, with the two accompanying printed "projects,"* being a sequel to the document which I forwarded to you on the 15th in my dispatch No. 1116.

I will thank you to transmit this document, as the previous one, to the Secretary of the Treasury.

I have the honor to be, very respectfully, your obedient servant,

E. B. WASHBURN.

Hon. HAMILTON FISH,
Secretary of State.

[Inclosure.]

Mr. Vignaud to Mr. Washburne.

PARIS, March 26, 1875.

SIR: On the 14th of this month I had the honor to send you a draught of two projects for the establishment of a permanent metrical institution, to one of which Germany, Russia, Austria, Spain, Italy, Switzerland, Belgium, and the United States had agreed, while England and several minor countries preferred the other. I informed you at the same time that a sub-committee had been appointed for the purpose of reconciling the two projects, if possible.

Unfortunately we have been unable to reach that end fully, but the conferences we had on the matter induced me and those with whom I have been associated to modify in some respects our former project, in order to make it more acceptable to the opposition. Having, then, made what we considered the utmost concessions possible under the circumstances, we drew up the project in its new shape, signed it, had it printed, and presented it to the commission as the definite result of our efforts. The other proceeded in the same manner. I inclose here with a copy of each of these projects.

At this stage of our proceedings we concluded that we had nothing more to do but to submit the matter to the diplomatic conference, and we had prepared for that purpose a collective declaration, which we intended to read at the opening of our meeting on the 23d. But on that day an unexpected declaration of Mr. Dumas, our president, rendered this move unnecessary, for the present at least. Mr. Dumas declared that the French Government had examined carefully the two projects proposed and that they agreed to the one we had submitted. He said that that project alone was calculated to promote the metrical system and to give to the International Bureau a real scientific value as well as a practical utility. He concluded by expressing the hope that the other party would assent to these views.

The delegates of Sweden and Norway declared immediately that they would, and the delegates of Turkey and Greece intimated that it was very likely that upon receiving further instructions they would do the same.

The commission then adjourned to next week in order to give time to the delegates of the opposition to consult their governments or their diplomatic agents and receive further instructions as to the course they should take.

* Not translated.

Practically our labors are at an end. We are to have a few more private meetings with the French delegates in order to give our project diplomatic shape and style.

Then it will go before the conference with the signature of at least twelve states, comprising all the great countries of the civilized world, England excepted.

I am, with much respect, your most obedient servant,

HENRI VIGNAUD.

Mr. E. B. WASHBURNE,
United States Minister.

No. 29.

Mr. Washburne to Mr. Fish.

No. 1127.]

LEGATION OF THE UNITED STATES,
Paris, April 8, 1875. (Received April 22.)

SIR: I have the honor to inclose herewith two copies of a third communication in the nature of a report by Mr. Henry Vignaud, in relation to the deliberations of the special commission of delegates appointed by the Metrical Diplomatic Conference, with the accompanying printed "project,"* being a sequel to the documents forwarded in my dispatches Nos. 1116 and 1124. I will thank you to transmit these documents, as the previous ones, to the Secretary of the Treasury.

I have the honor to be, very respectfully, your obedient servant,

E. B. WASHBURNE.

Hon. HAMILTON FISH,
Secretary of State.

P. S.—Mr. Vignaud has just handed me two printed copies each of the journal of the commission until the sixth meeting and of project No. 2, which I have the honor to forward with the above mentioned.—E. B. W.

[Inclosure.]

Mr. Vignaud to Mr. Washburne.

PARIS, April 4, 1875.

SIR: I inclose herewith three copies of the definitive project of the metrical convention adopted by France, Germany, Austria, Russia, Italy, Belgium, Switzerland, and the United States.

With the concurrence of the French *bureau du protocole*, to which all diplomatic documents are to be referred, we have carefully revised its wording, and we hope the diplomatic conference will find it in such shape that it can be adopted at once.

I understand that a meeting of the conference is to be called on Friday.

I am, with much respect, your most obedient servant,

HENRI VIGNAUD.

Hon. E. B. WASHBURNE,
United States Minister, Paris.

No. 30.

Mr. Washburne to Mr. Fish.

No. 1131.]

LEGATION OF THE UNITED STATES,
Paris, April 14, 1875. (Received April 29.)

SIR: Since my No. 1127, April 8, on the subject of the Metrical Conference, another meeting was held on Monday last, the 12th instant. The Duke Decazes, upon calling the meeting to order, stated that a special commission having been created by a resolution of the conference at its first meeting to prepare a project of a convention, that commission had, after giving great care to the subject, drawn up two projects which would be submitted. You will have received copies of both these projects with my dispatch No. 1127.

Mr. Dumas, the chairman of the commission, then read the report, gave a summary of the proceedings of the commission, and a sketch of the two projects. The Duke Decazes stated that it would be in order to take the sense of the plenipotentiaries on these two projects, and Dr. Kern, the Swiss minister, having moved to proceed to vote, it appeared that thirteen states voted in favor of project number one, and a single state, Holland, for number two; while the representatives of the six remaining states asked delay, desiring that that the protocol might be kept open until they could receive further instructions from their governments.

* Not translated.

I voted in favor of project number one, stating at the same time, distinctly, that my action was subject to the approval of my government. A similar statement was made by other plenipotentiaries who agreed to this project. While I might have entirely deferred giving my vote until I should have received further instructions, as did six others, I deemed it advisable to take position, with the reservation stated, at once, in order that our government might participate in the organization of the International Commission which must be created without delay. I was also confirmed in this view by the fact that project number one agrees in all its provisions with the instructions I have already received. You will have observed that by the text of that project Mr. Hilgard is made a permanent member of that organization, and as he has sent his proxy for Mr. Herr, the delegate from Austria, our government will be at once efficiently represented in the commission.

Another meeting will be held on Thursday (to-morrow), in order to sign the journal of the conference. Then, after a delay of twelve or fifteen days, to afford time to draught an adequate number of copies of the convention, equal to the number of states agreeing, it will be formally signed. While it is true that I may then sign the convention, with the declared reservation that it is done subject to the approval of my government, it would be better if it could be done after the approval of the department had been received. There will be time after the receipt of this dispatch by you to telegraph your approval or disapproval of the convention, which is in fact project number one already forwarded to you. I suggest, therefore, that you send me a cable dispatch signifying your wishes.

The states whose representatives have asked delay before declaring positively for the convention, viz., Turkey, Denmark, Great Britain, Greece, Pern, and Portugal, will, as their representatives state, be almost certain to sign the convention, unless it be Great Britain. Her position is very doubtful. You will have observed that she has had no plenipotentiary, but has been represented by her delegate, Mr. Chisholm.

I have the honor to be, very respectfully, your obedient servant,
E. B. WASHBURNE.

Hon. HAMILTON FISH,
Secretary of State.

No. 31.

Mr. Washburne to Mr. Fish.

No. 1134.]

LEGATION OF THE UNITED STATES,
Paris, April 16, 1875. (Received April 29.)

SIR: As announced in my dispatch No. 1131, another meeting of the Diplomatic Metrical Conference was held on yesterday, the purpose being to consider the precise text of the project adopted and authenticate it by preliminary signatures, that from it a sufficient number of copies might be prepared to be formally signed as the convention by the agreeing states. The representative of Peru added that government to the thirteen previously consenting to project number one. It was agreed that the convention should be formally signed May 20, and that the ratifications should be exchanged within six months from that date. I accepted this last condition, which it was stated would meet the convenience of the majority of the plenipotentiaries, but with the distinct understanding that I could not be ready at that time for the exchange of ratifications, and should then ask a further delay.

The interval between the receipt of this dispatch and the 20th of May will, I suppose, afford time enough to consider the question of the acceptance or rejection of the convention, and also to inform me fully by letter of the decision of the government. In my last dispatch on this subject I stated that twelve or fifteen days of delay would probably occur before finally signing, but by the action of yesterday you will perceive that the conference was liberal enough to allow until the 20th May, upon my stating that this would afford sufficient time to my government to examine the convention and advise me in regard to my action.

Agreeably to the telegram and letter of Professor Hilgard, in the nature of instructions to me, I have given the proper authority to Dr. Herr to act for him in the organization of the International Bureau, this action, however, to be subject to my approval. I beg leave to inclose herewith the printed journals* of the seventh and last session of the special committee and of the first meeting of the Diplomatic Metrical Conference, held on the 1st of March.

I have the honor to be, very respectfully, your obedient servant,
E. B. WASHBURNE.

Hon. HAMILTON FISH,
Secretary of State.

H. Rep. 14—10

* Not translated.

METRIC SYSTEM.

No. 32.

*Mr. Bristow to Mr. Fish.*TREASURY DEPARTMENT,
Washington, D. C., April 17, 1875. (Received April 19.)

SIR: I have the honor to acknowledge the receipt of your letter of the 3d instant, transmitting copy of a dispatch, No. 1116, from the minister of the United States at Paris, dated March 16, 1875, in relation to the Diplomatic Metrical Conference, with printed pamphlets accompanying it, and also your letter of the 13th instant, transmitting for the information and opinion of the department copy of a dispatch, No. 1124, dated March 26, 1875, from the minister of the United States at Paris, with two projects, printed in the French language, in relation to the same conference.

Before taking action in this matter, I have to request an expression of opinion from you upon the following statement:

It is understood that the Diplomatic Metrical Conference proposes the organization and establishment, at or near Paris, of an International Bureau of Weights and Measures, the expense of which is to be borne by the respective governments participating in the scheme; the proportion of expense to our government, should it connect itself with the institution, being estimated at about \$2,000 per annum for two years, and from \$800 to \$1,000 per annum thereafter.

It is further understood that the American minister at Paris, representing our government in the conference, has given his assent to the proposed organization and establishment of the International Bureau of Weights and Measures referred to, subject, as is inferred from your letter to the department of January 22, 1875, to the future approval of the government.

I inclose a draught of a letter dated April 8, 1875, from Mr. C. P. Patterson, Superintendent of United States Standard Weights and Measures, advising that the department signify to the Department of State its concurrence in the action of the United States minister representing this country in the conference. In view of the facts as set forth, and also of the statute provision (see sections 3679 and 3681, Revised Statutes, page 728) prohibiting any department or any officer of the government from involving the government in future liability for the payment of money without express authority of Congress and an appropriation therefor, I submit whether the action proposed by the Superintendent of United States Standard Weights and Measures can be taken without committing the government to the future expenditure of money involved in participation in the scheme; and if not, I would thank you to suggest some plan of action which can be properly pursued that shall not so commit the government.

I am, very respectfully,

B. H. BRISTOW,
Secretary.Hon. HAMILTON FISH,
Secretary of State.

[Inclosure.]

*Mr. Patterson to Mr. Bristow.*UNITED STATES COAST SURVEY OFFICE,
Washington, April 8, 1875.

SIR: Referring to department's letter of yesterday's date (S. I. K.), transmitting papers relative to the Diplomatic Metrical Conference, I would respectfully advise that the Treasury Department signify to the Department of State its entire concurrence in the action of the United States minister, representing this country in the conference, and that it transmit with its approval to that department the request of Mr. Hilgard to confide his vote, as member of the International Metric Commission (if constituted), to Professor Herr, member from Austria, by telegram, through the American minister at Paris.

Yours, respectfully,

C. P. PATTERSON,
Superintendent United States Coast Survey.Hon. B. H. BRISTOW,
Secretary of the Treasury.

METRIC SYSTEM. 147

No. 33.

*Mr. Fish to Mr. Bristow.*DEPARTMENT OF STATE,
Washington, April 24, 1875.

SIR: I have the honor to acknowledge the receipt of your letter of the 17th of April, referring to dispatches 1116 and 1124, from the minister of the United States in Paris, and their inclosures, in reference to the Metrical Conference.

You state that this Diplomatic Metrical Conference proposes to establish an International Bureau, the expense of which is to be borne by the governments participating, amounting to some \$2,000 for the first year, and \$800 to \$1,000 per annum afterward, and that it is understood that the minister of the United States has given his assent to the proposed organization, subject to the approval of this government.

In view of these facts you inclose a copy of a letter from the Superintendent of the United States Standard Weights and Measures, and ask whether the action proposed by him can be taken without committing this government to the scheme and to the future expenditure; and, if not, you ask me to submit some plan which may be adopted without such committal.

Upon examination of the letter of the Superintendent of Standard Weights and Measures referred to, a copy of which is annexed to your letter, he appears to recommend the approval of the acts of Mr. Washburne at the Diplomatic Conference, as reported by him, and that the Treasury should transmit to the Department of State the request of Mr. Hilgard to confide his vote as a member of the International Metric Committee (if constituted) to Professor Herr, member from Austria, by telegram, through the American minister at Paris.

Upon an examination of the correspondence on the question it would seem that the object of the conference was to conclude a convention securing an international organization for the custody of the standards and their preservation, subject to the approval of the various governments.

It would appear that such agreement partakes of the nature of a treaty or convention binding this government to contribute to the annual support of a permanent establishment, and I respectfully submit to your consideration whether any binding engagement can be made, either as to contribution or in other respects, short of the formalities usual in reference to such matters.

Mr. Washburne was specially instructed that the results of the conference must be reported to this government for approval before any positive engagement was entered into.

The report of Mr. Vignaud dated March 14, inclosed with Mr. Washburne's No. 1116, contemplates that the engagement was provisionally executed, and was submitted for approval.

With reference to the matter of Mr. Hilgard's vote, which, by the report of Mr. Vignaud, and from the recommendation of the Superintendent of Weights and Measures, it is proposed to confide by telegraph to the member of the new committee, from Austria, to be cast at the organization of the body contemplated by this conference, I am not informed precisely as to the purpose of the vote.

It would appear in general that the organization of a body the actual existence of which depends on future approval by the various governments should not take place until such approval was obtained.

Should the casting of a vote be necessary, and be deemed by you expedient, it might be possible to make such reservations at the time of doing so as to leave no room for presuming any committal of this government.

I have the honor to be, sir, your obedient servant,

Hon. BENJAMIN H. BRISTOW,
Secretary of the Treasury.

HAMILTON FISH.

No. 1140.]

No. 34.
*Mr. Washburne to Mr. Fish.*LEGATION OF THE UNITED STATES,
Paris, April 29, 1875. (Received May 14.)

SIR: I have the honor to transmit herewith for transmission to the Secretary of the Treasury a translation of a communication from the members of the International Committee of Weights and Measures, notifying our government of the choice of officers by said committee.

I have the honor to be, very respectfully, your obedient servant,

Hon. HAMILTON FISH,
Secretary of State.

E. B. WASHBURN.

[Inclosure.—Translation.]

PARIS, April 22, 1875.

SIR: In conformity with the sixth article of the transitional dispositions of the Convention of Weights and Measures, and authorized by the decision of the Diplomatic Metrical Conference at its session of April 15, 1875, the International Committee of Weights and Measures met and held its first session April 19, at the Hotel of the Department of Foreign Affairs.

In conformity with article 10 of the rules subjoined to the convention, we have the honor, sir, to inform your government that the international committee, which assembled after due notice to the three absent members that they could exercise their conventional right to vote by delegates, elected General Ibáñez, president, and Dr. Hirsch, secretary, and that at the session of April 20 it invited Professor Govi to discharge the functions of director of the Bureau of Weights and Measures until the definitive nomination shall be made.

Please accept, sir, the expression of our very high consideration.

The members of the International Committee of Weights and Measures present at the session of organization:

DR. O. I. BROCH.
DR. W. FOERSTER.
GILBERT GOVI.
DR. JOS. HERR.
DR. HIRSCH HUSNY.
GENERAL IBÁÑEZ.
GENERAL MORIN.
DR. H. WILD.
J. S. STAS.
WREDE.

Hon. E. B. WASHBURN, &c., &c., &c.

No. 35.

Mr. Hilgard to Mr. Cadwalader.

[Informal.]

UNITED STATES COAST SURVEY OFFICE,
Washington, May 3, 1875. (Received May 4.)

DEAR SIR: I beg leave to place in your hands herewith, informally, a copy of resolutions adopted by the National Academy of Sciences, relative to the proposed International Bureau of Weights and Measures. The same have been to-day formally transmitted to the President by Professor Henry; but I anticipate their reception at the Department of State, in view of their bearing upon a communication from the Treasury Department, which will have been received by you to day.

Yours, &c.,

J. E. HILGARD.

[Inclosure.]

Resolutions adopted by the National Academy of Sciences at its session April 22, 1875.

Resolved, That, in the opinion of the National Academy of Sciences, an International Bureau of Weights and Measures is an instrumentality practically indispensable for the complete and satisfactory accomplishment of the important objects for which the international commission of 1870 and 1872 was convened, viz: the perpetuation, unaltered forever, of the basic units of the metric system of weights and measures; the construction, verification, and distribution to the different sections of authenticated copies of the prototype standards representing those units; the recomparison of such copies hereafter, and the construction and verification of new copies for the uses of the scientific bodies and of other organizations and individuals engaged in the conduct of important public works or in the grand operations of international commerce; and, finally, for the preservation and proper care of the valuable apparatus and instruments employed in such constructions and comparisons.

Resolved, That it is eminently desirable that our country should participate in the honor of maintaining an institution destined to exercise hereafter an influence so beneficial to the material interests of the human race, by securing that exactness in

the determination of quantities which is so essential to the success of human calculations, and that precision in the results of scientific investigation without which progress beyond a certain rudely-defined limit is impossible; and that the President of the United States be accordingly respectfully solicited to ratify the assent which is understood to have been provisionally given by his diplomatic representative in Paris to the creation of such a bureau, and to recommend to Congress to make the necessary provision to defray such portion of the expense attending its maintenance as may properly fall to our share.

Resolved, That a copy of these resolutions, authenticated by the signatures of the proper officers of the academy, be forwarded by the president of the academy to the President of the United States.

True copy.

J. E. HILGARD,
Home Secretary National Academy of Sciences.

No. 36.

Mr. Conant to Mr. Fish.

TREASURY DEPARTMENT,
Washington, D. C., May 5, 1875. (Received May 6.)

SIR: I have the honor to acknowledge the receipt of your communication of the 24th ultimo, in relation to the question of department action committing the government in the matter of the Diplomatic Metric Conference, and also your communication of the 29th ultimo, transmitting dispatches Nos. 1131 and 1134, from the American minister in Paris, with papers relative to the proceedings of the conference, and particularly referring to the latter communication. I have to inform you that the convention agreed upon for the establishment of an International Bureau of Weights and Measures is entirely in accordance with the views of the department. I deem it advisable, therefore, that the matter be proceeded with on the part of this government as far as its usage in similar cases will admit of.

In this connection it is important to observe that the last article of the convention (*Dispositions transitoires*, Article 6) expressly provides that no expense shall be incurred before the exchange of ratifications, being in these terms: "The international committee is authorized to organize immediately and to take the necessary preparatory steps for putting the convention in execution, without incurring any expense, however, before the exchange of ratifications of the said convention."

It would thus appear that the signing of the convention by Mr. Washburne, with the reserve expressed in his dispatch No. 1134, and the subsequent participation of Mr. Hilgard in the organization of the international committee and in its deliberations, would in no wise violate that provision of law which forbids contracting pecuniary obligations without previous authorization by Congress. Moreover, it appears desirable that the participation of the United States in this undertaking of admitted general utility should not be needlessly interrupted.

If, therefore, the Department of State sees no objection to the above proposition, I would request that Mr. Washburne be instructed to act in accordance therewith.

The dispatches Nos. 1131 and 1134 are herewith returned, as requested by your communication of the 29th ultimo.

I have, &c.,

CHAS. F. CONANT,
Acting Secretary.

No. 37.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, May 8, 1875.

SIR: I have the honor to acknowledge the receipt of the note of May 5, from the Acting Secretary of the Treasury, in reference to the Diplomatic Metric Conference, with which are returned dispatches Nos. 1131 and 1134 from the minister of the United States in Paris.

Referring particularly to dispatch 1134, I am informed [by you] that the convention agreed upon for the establishment of an international bureau is entirely in accordance with the views of your department, and that it is deemed advisable that the matter

be proceeded with on the part of this government as far as usage in similar cases will allow, and I am requested, in case this department sees no objection to the propositions contained in the letter, that Mr. Washburne be instructed to act in accordance therewith.

In reply, I have to say that, pursuant to such request, a copy of the letter of the Acting Secretary will be forwarded to Mr. Washburne by the next mail for his guidance.

It will be observed, however, that in Mr. Washburne's 1131 he requests definite instructions as to what course he shall pursue; and in his 1134 it is stated that the text of the convention is to be formally signed May 20, and ratifications are to be exchanged within six months, although Mr. Washburne intimates that he shall then ask for further delay.

It is not probable that the copy of the communication referred to can reach Mr. Washburne by the 20th May. It may be that some legislation will be required before this government can formally be bound by the convention.

Should you have any directions to give to Mr. Washburne, in view of any of these facts, I will thank you to inform me.

I have, &c.,

HAMILTON FISH.

No. 38.

Mr. Cadwalader to Mr. Washburne.

No. 700.]

DEPARTMENT OF STATE,
Washington, May 11, 1875.

SIR: Your dispatches, Nos. 1131 and 1134, in reference to the Metrical Diplomatic Conference, have been received and submitted to the Treasury Department; and I transmit herewith a copy of certain late correspondence that has taken place with the Treasury on this question.

Upon the receipt of the communication of the Acting Secretary of the Treasury dated May 5, 1875, that department was informed that an instruction to be addressed to you pursuant to that request would hardly reach you by the ordinary channels prior to the 20th May, and it was suggested, in case any other course were desired by that department, that information be furnished thereof.

Pending a reply from the Treasury, the correspondence that has taken place up to this time is forwarded for your information.

You will perceive from the communication of May 5, above referred to, the views of the Treasury concerning your action, as reported in your No. 1134.

I am, &c.,

JOHN L. CADWALADER,
Acting Secretary.

No. 39.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
Washington, D. C., May 14, 1875. (Received May 17.)

SIR: In view of the statement contained in your letter of the 8th instant in relation to the Diplomatic Metric Conference, that it is not probable that the letter of instruction to Mr. Washburne can reach him in time to sign the convention in question, I would suggest, if no objection occur to you, that in conformity with his own suggestion, contained in dispatch No. 1134, a telegram be sent him, substantially to the following effect:

"Sign convention with reserves expressed in your dispatch 1134, and deliver Hilgard's proxy with reserve of article 6 of provisions of transitories."

I have, &c.,

B. H. BRISTOW.

No. 40.

Mr. Fish to Mr. Washburne.

[Telegram.]

WASHINGTON, May 17, 1875.

At request of Treasury, sign convention with reserves expressed in 1134, and deliver Hilgard's proxy with reserve of article six of provisions transitories.

FISH.

No. 41.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, May 18, 1875.

SIR: I have the honor to acknowledge the receipt of your letter of the 14th of May in relation to the Diplomatic Metric Conference, and to inform you that, as requested by you, the following telegram was sent yesterday to Mr. Washburne, viz:

"At request of Treasury, sign convention with reserves expressed in 1134, and deliver Hilgard's proxy with reserve of article six of provisions transitories."

I have, &c.,

HAMILTON FISH.

No. 42.

Mr. Washburne to Mr. Fish.

No. 1167.]

LEGATION OF THE UNITED STATES,
Paris, May 28, 1875. (Received June 10.)

SIR: I have the honor to send you by the dispatch bag of this day, separately inclosed, the convention* which was agreed upon by the Diplomatic Metrical Conference, signed by all the contracting parties.

I also inclose three printed copies of the proceedings of the fourth and last session of the conference.

I have, &c.,

E. B. WASHBURN.

[Inclosure with No. 1167.—Translation.]

FOURTH AND LAST SESSION,
Thursday, May 20, 1875.

Under the presidency of His Excellency the Duke Decazes.

Present:

For Germany.—His Highness Prince VON HOHENLOHE-SCHILLINGSFÜRST, Ambassador Extraordinary and Plenipotentiary of H. M. the Emperor of Germany.

For the Argentine Confederation.—Mr. BALCARCE, Envoy Extraordinary and Minister Plenipotentiary.

For Austria-Hungary.—His Excellency Count APPONYI, Ambassador Extraordinary of H. M. the Emperor of Austria.

For Belgium.—Baron BEYENS, Envoy Extraordinary and Minister Plenipotentiary of H. M. the King of the Belgians.

For Brazil.—Viscount d'ITAJUBA, Envoy Extraordinary and Minister Plenipotentiary of H. M. the Emperor of Brazil.

For Denmark.—Count VON MOLTKE-HVITFELDT, Envoy Extraordinary and Minister Plenipotentiary of H. M. the King of Denmark.

For Spain.—His Excellency the Marquis de MOLINS, Ambassador Extraordinary and Plenipotentiary of His Catholic Majesty, and General IBAÑEZ, Director-General of the Geographical and Statistical Institute of Spain and member of the Academy of Sciences of Madrid.

For the United States of America.—Mr. WASHBURN, Envoy Extraordinary and Minister Plenipotentiary.

For France.—Duke DECAZES, Minister of Foreign Affairs; Viscount de MEAUX, Minister of Agriculture and Commerce; and M. DUMAS, ex-minister, Perpetual Secretary of the Academy of Sciences.

For Italy.—Chevalier NIGRA, Envoy Extraordinary and Minister Plenipotentiary of H. M. the King of Italy.

For Peru.—DON PEDRO GALVEZ, Envoy Extraordinary and Minister Plenipotentiary, and Don FRANCISCO DE RIVERO, formerly Minister Plenipotentiary.

For Portugal.—Senhor JOSÉ da SILVA MENDES LEAL, Envoy Extraordinary and Minister Plenipotentiary of H. M. the King of Portugal.

For Russia.—M. OKOUNEFF, Counselor of State, and Counselor of Embassy.

For Sweden and Norway.—Mr. AKERMAN, representing the Envoy Extraordinary and Minister Plenipotentiary of H. M. the King of Sweden and Norway, Baron ADELSTÅRD, who is unable to attend the meeting.

*See Document No. 1.

For Switzerland.—Mr. KERN, Envoy Extraordinary and Minister Plenipotentiary of the Helvetic Confederation.

For Turkey.—HUSNEY BEY, Lient. Colonel of the General Staff.

For Venezuela.—Doctor ELISEO ACOSTA.

The sitting opened at two o'clock.

Conformably with the decision reached at the last sitting, the plenipotentiaries have met to-day, the 20th of May, at the Ministry of Foreign Affairs, to proceed to the signing of the convention.

After having mutually communicated their full powers, the plenipotentiaries compared with the original paragraphed copy the engrossed copies of the convention and its annexes, which were prepared in number equal to that of the contracting states; and, all these acts being found in good and due form, the plenipotentiaries thereto set their signatures and the seal of their arms.

In consideration of the great number of contracting parties, and following a mode of procedure already adopted at the time of the ratification of the treaties relative to the confirmation of the Sound and Scheldt dues and of the telegraphic convention of Paris, the conference decided the proposal of Duke Decazes, that the exchange of the ratifications of the metrical convention shall be effected through the intervention of France.

The conference decides, moreover, that the act which has just been signed shall be brought officially to the cognizance of all the non-signatory states, who would thus, through this courteous step, be equally free to exercise the discretionary power of accession which is open to them by Article 11 of the convention.

At the proposal of Chevalier Nigra, accepted by the conference, it is understood that such communication shall be made by the French Minister of Foreign Affairs.

The present *procès-verbal*, drawn up during the sitting, being read and approved, the conference broke up at 3½ o'clock.

HOHENLOHE.
BALCARCE.
APPONYI.
BEYENS.
VISCOUNT D'ITAJUBA.
L. MOLTKE-HVITFELDT.
MOLINS.
IBANEZ.
E. B. WASHBURNE.
DECIZES.
C. DE MEAUX.
DUMAS.
NIGRA.
P. GALVEZ.
FRANCISCO DE RIVERO.
MENDEZ LEAL.
OKOUNEFF.
H. AKERMAN,
For Baron Adelswärd, prevented.
KERN.
HUSNY.
E. ACOSTA.
ERNEST CRAMPON,
Secretary of the Conference.

No. 43.

Mr. Washburne to Mr. Fish.

No. 1169.]

LEGATION OF THE UNITED STATES,
Paris, May 28, 1875. (Received June 10.)

SIR: I have the honor to acknowledge the receipt of your dispatch No. 700 transmitting a copy of certain correspondence that has taken place with the Treasury Department on the subject of the Metrical Convention.

It appears, on referring to that correspondence, that a doubt has existed as to the extent to which my action might involve the government in future liabilities, and the propriety of organizing a body the actual existence of which depends on a future approval.

Though by the note of May 5 of the Acting Secretary of the Treasury that doubt seems to have disappeared, I will take the liberty to add here further explanations.

During the whole of the proceedings of the diplomatic conference, I have been careful to neither give my formal assent to any proposition, nor affix my signature to any-

thing, without first stating that it was done subject to the approval of my government.

By referring to the *procès-verbal* of our second meeting, April 12th,* you will see (page 13) that in assenting to project No. 1, I said it was under the reservation of the future approval of my government.

At the next meeting, April 16, called for the purpose of giving to that project the form of an international convention to authenticate its text by preliminary signatures, and to fix the time for the exchange of ratifications, I assented to the delay of six months; but I stated, at the same time, it would not be sufficient for me and I had it inserted in the *procès-verbal* (page 6) that at the expiration of that period I would be entitled to another delay. At the same meeting we decided that the convention should be formally signed on the 20th of May, and, according to your instructions, I affixed my signature on that day.

But I beg leave to remark that that signature binds the government no further than the conditional approval given by me at the same meeting of the conference. In fact, it is the same thing. When I stated, at that second meeting, that I was ready to sign, subject to your approval, the Duke Decazes, president of the conference, took care to explain that certain governments, who then approved the convention, were themselves acting subject to the approval of their legislatures. It is, therefore, distinctly understood that the convention, as I send it to you, will be null and void as far as concerns the United States if not ratified within the time above-mentioned.

As for the immediate organization of the international committee, its necessity was obvious. Scientific men of high standing had been called together from distant countries, and if they had not organized at once, no such opportunity would have been found again. It was therefore decided that they should be authorized to do so, with the understanding, however, that their action should not involve any expense for the states participating before the exchange of the ratifications; and this clause was made part of annex No. 2 (*dispositions transitoires*) to the treaty, article 6.

Under those circumstances, I thought it was to the interest of our country that Mr. Hilgard, who was made a member of the International Committee by article 8 of annex No. 1 (*Règlement*) to the convention, should be put in a situation to take part in the definitive organization of the International Bureau of Weights and Measures.

I have, &c.,

E. B. WASHBURNE.

No. 44.

Mr. Cadwalader to Mr. Washburne.

No. 713.]

DEPARTMENT OF STATE,
Washington, June 11, 1875.

SIR: Your No. 1169, in which you make further explanations in connection with the International Metrical Convention, has been received.

The convention assigned by the several delegates has also been received. The department has remarked the care taken by you, pursuant to your instructions, to avoid committing the government before the necessary formal approval shall have been obtained. It is, perhaps, proper to say that the correspondence with the Treasury, a copy of which was transmitted to you, and which is referred to in your dispatch, was not occasioned by any doubt as to your action, or from any fear of a complication through your acts. It was, however, thought proper, in this and much other correspondence with the Treasury on this question, to place the matter clearly before that department.

I am, &c.,

JOHN L. CADWALADER,
Acting Secretary.

No. 45.

Mr. Hitt to Mr. Fish.

No. 1264.]

LEGATION OF THE UNITED STATES,
Paris, December 10, 1875. (Received December 23.)

SIR: I have the honor to transmit herewith inclosed a communication from General Ibáñez, president of the International Committee of Weights and Measures, accompanied by a table of the contributions for the support of the bureau, calculated in

*Not translated for transmission herewith.

conformity with article 9 of the convention recently entered into, and article 20 of the regulations thereto attached, of which contributions it will be seen that the proportion assigned to the United States amounts to 38,854 francs for the establishment of the bureau, and 7,285 francs for the annual expenses of next year.

I suggest that these papers be placed before Professor Hilgard, that he may verify the calculations before any action is taken. If the convention is confirmed by the Senate, we will, of course, be bound to pay our contribution.

I have, &c.,

R. R. HITT.

[Inclosure 1 with No. 45.—Translation.]

General Ibañez to Mr. Washburne.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES,
Neuchâtel, November 29, 1875.

M^r. MINISTER: We have the honor to transmit to your excellency the table of the contributions for International Bureau of Weights and Measures, calculated conformably with article 9 of the convention and article 20 of the regulations, and based upon the official data which we have received from the contracting governments, and in particular from your excellency by the letter which you were pleased to address us the 19th of last July.

It appears from the table that the part to be contributed by the United States of America is 38,854 francs for the costs of establishment, payable at the commencement of 1876 according to article 10 of the convention; 7,285 francs for annual expenses during the first period, likewise payable at the commencement of 1876; and 4,857 francs for the annual expenses of the subsequent period.

We have to state that the delay in making the final calculation of the contributions is due solely to the fact that the committee did not receive until the 26th of October the last official information asked for on the 7th of June. We have at once calculated the table and thereupon have circulated it among the members of the committee, and we hasten to transmit it to your excellency at the very moment of receiving the approbation of the committee.

Accept, sir, &c.,

Dr. AD. HIRSCH, Secretary.

GENERAL IBAÑEZ, President.

[Inclosure 2 with No. 45.]

Table showing the amounts to be contributed by the different states toward the International Bureau of Weights and Measures.

States.	Population.	Co-efficient.	Product to nearest million	Annual expenses.	
				Initial expense, F. 300,000.	1st period, F. 75,000.
					Unit, F. 498.13.
1 Germany	41,010,150	3	123	F. 61,270	F. 11,488
2a { Austria	20,136,283	3	60	29,888	5,604
2b { Hungary	15,508,575	3	47	29,412	4,390
3 Belgium	5,253,221	3	16	7,970	1,494
4 Argentine Confederation	2,000,000	2	4	1,993	374
5 Denmark	2,000,000	1	2	996	187
6 Spain	24,236,590	3	73	36,363	6,818
7 United States of America	38,925,598	2	78	38,854	7,285
8 France	40,943,120	3	123	61,270	11,488
9 Italy	26,801,154	3	80	39,850	7,472
10 Peru	2,500,000	3	8	3,985	747
11 Portugal	5,400,000	3	16	7,970	1,494
12 Russia	76,500,000	1	77	38,356	7,192
13a { Sweden	4,341,559	1	4	1,993	374
13b { Norway	1,795,000	2	4	1,993	374
14 Switzerland	2,669,147	2	5	2,491	467
15 Turkey	39,000,000	2	78	38,854	7,285
16 Venezuela	1,784,194	3	5	2,491	467
Total	350,850,191	...	803	399,999	75,000
					50,002

No. 46.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
December 17, 1875. (Received December 18.)

SIR: I have the honor to inclose herewith a copy of a letter of this date from Mr. J. E. Hilgard, assistant United States Coast Survey, in which reference is made to the fact that in signing the convention for the establishment of an International Bureau of Weights and Measures the American minister at Paris reserved the privilege of asking a further delay on the part of the United States on account of the impracticability of obtaining the action of the Senate before the 20th of the present month, which was the date fixed on for ratification; and it is suggested that a telegram be sent to the American minister at Paris requesting a delay until the 20th of March, 1876, in order to give full time to the Senate for discussion.

I have therefore to request that, if not inconsistent with the public interests committed to your charge, you will cause a telegram to be sent to the American minister at Paris, requesting him to ask that the ratification of the convention referred to be delayed on the part of the United States until the 20th of March, 1876.

I have the honor to be, sir, your obedient servant,

B. H. BRISTOW,
Secretary.

HON. HAMILTON FISH,
Secretary of State.

[Inclosure.]

Mr. Hilgard to Mr. Bristow.

BUREAU OF WEIGHTS AND MEASURES,
UNITED STATES COAST SURVEY OFFICE,
December 17, 1875.

SIR: In view of the fact that the convention for the establishment of an International Bureau of Weights and Measures was to be ratified on the 20th instant, and that the American minister in signing the convention reserved the privilege of asking a further delay on the part of the United States, on account of the impracticability of obtaining the action of the Senate before that date, I would respectfully suggest that the Secretary of State be requested to telegraph to the American minister at Paris to ask for such delay at the time fixed for the exchange of ratifications. As the matter is not pressing in its nature, I would suggest a delay until the 20th of March, 1876, which will give full time for discussion.

Very respectfully,

J. E. HILGARD,
Assistant in Charge, for Superintendent of Weights and Measures.
Hon. SECRETARY OF THE TREASURY.

No. 47.

Mr. Fish to Mr. Hitt.

[Telegram.]

WASHINGTON, December 18, 1875.
Treasury requests extension time for ratification Metrical Convention, if not already provided. See Washburne's eleven hundred and sixty-nine.

FISH.

No. 48.

Mr. Hitt to Mr. Fish.

[Telegram, received at 1:30 p. m., December 19, 1875.]

PARIS.

FISH, Secretary, Washington :
Will to-morrow ask extension two months for ratification.

HITT.

No. 49.

Mr. Hitt to Mr. Fish.

No. 1270.]

LEGATION OF THE UNITED STATES,
Paris, December 20, 1875. (Received Jan. 6, 1876.)

SIR: At two o'clock this afternoon the diplomatic representatives of Belgium, Denmark, France, Germany, Italy, Peru, Russia, Spain, Sweden and Norway, Switzerland, and Turkey, exchanged ratifications of the International Metrical Convention, in the manner prescribed by the protocol of the conference of May 20, 1875. The proceedings took place at the Palace of Versailles, instead of Paris, in consequence of the fact that the Duke Decazes was kept all day at Versailles, by a council of ministers in the forenoon, and the session of the Assembly, still engaged in balloting for senators, in the afternoon.

There was at first informal conversation in regard to the position of each of the powers represented. I stated, in conformity with your telegram of Saturday, that our government desired an extension of the time fixed for ratification; that the Senate having recently convened had not yet acted on the convention, and I therefore asked two months' delay. Similar remarks were made by several others, all of which observations were then restated by the Duke Decazes, in formal summary as you will see fully set forth in the printed proceedings, of which I inclose two copies. The delays asked were accorded.

In pursuance of a suggestion from Dr. Kern, the Swiss minister, it was understood that these extensions of the time of ratification should not operate to delay the date, January 1, 1876, fixed by article 14, for putting the convention in execution; and that the proportion of the contributions to be paid by each of the powers who might hereafter exchange ratifications should be the same as if they had exchanged ratifications to-day.

I have, &c.,

R. R. HITT.

[Inclosure.—Translation.]

Minutes of the sitting held at the Château of Versailles, December 20, 1875, for the exchange of the ratifications of the Metrical Convention.

Present:

For Germany.—Count VON WESDEHLEN, Chargé d'Affaires.

For Belgium.—Baron BEYENS, Envoy Extraordinary and Minister Plenipotentiary.

For Denmark.—Count VON MOLTKE-HVITFELDT, Envoy Extraordinary and Minister Plenipotentiary.

For Spain.—H. E. the Marquis DE MOLINS, Ambassador Extraordinary and Plenipotentiary.

For the United States of America.—Mr. HITT, Chargé d'Affaires.

For France.—H. E. the Duke DECAZES, Minister of Foreign Affairs.

For Italy.—Chevalier NIGRA, Envoy Extraordinary and Minister Plenipotentiary.

For Peru.—Mr. PEDRO GALVEZ, Envoy Extraordinary and Minister Plenipotentiary.

For Russia.—M. OKOUNEFF, Counselor of State and Embassy.

For Sweden and Norway.—Baron ADELSWÄRD, Envoy Extraordinary and Minister Plenipotentiary.

For Switzerland.—Mr. KERN, Envoy Extraordinary and Minister Plenipotentiary.

For Turkey.—NASRI Bey, First Secretary of Embassy.

His Excellency Duke Decazes made the following communications:

The project of convention voted by the Chambers of Deputies of Austria and Hungary has hitherto not been submitted to the deliberations of the Chambers of Lords of those two countries. Although this delay makes it impossible for the Austro-Hungarian Government to co-operate in the immediate exchange of the ratifications, the question of principle is in no wise affected thereby, and His Excellency Count Apponyi has been authorized to declare in the most formal manner that his government tacitly considers the convention as entering into operation at the epoch fixed, and has no objection to all necessary measures being forthwith taken by the international committee.

The Portuguese Government has not obtained the legislative sanction of the Parliament, which resumes its sessions on the 2d of next January, and the Government of the United States of America is in like manner obliged to await the vote of the Senate, whose sessions is now about to open. These two governments have, therefore, need of a delay of about two months in the production of their ratifications.

"The Argentine Republic and Venezuela solicit on their part the favor of a delay of indeterminate duration.

"One only of the states signing the convention, Brazil, has, in the last place, resolved not to join in the common work."

Conformably with the clause inserted in the protocol of the conference of April 15, 1875, the delays requested by the divers states are accorded.

It is well understood, however, that these delays in no manner affect the 14th article of the convention fixing the epoch of its taking effect, and that, consequently, the proportional pecuniary charges depending thereon shall be borne from the 1st of January, 1876, by those among the contracting states which may exchange their ratifications later, the same as by those which have found themselves enabled to do so to-day.

The exchange of the ratifications between Germany, Belgium, Denmark, Spain, Italy, Peru, Russia, Sweden and Norway, Switzerland, Turkey, and France, was then effected, following the procedure agreed upon and determined in the protocol of the conference of May 20, 1875.

The ulterior exchange of the postponed ratifications, so soon as effected, shall be brought to the cognizance of the contracting states by a circular letter of the French Minister of Foreign Affairs.

WESDEHLEN.
BEYENS.
L. MOLTKE-HVITFELDT.
MOLINS.
DECAZES.
NIGRA.
P. GALVEZ.
OKOUNEFF.
G. ADELSWÄRD.
KERN.
NASRI.

ERNEST CRAMON,
The Secretary of the Conference.

No. 50.

Mr. Cadwalader to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, December 28, 1875.

SIR: Referring to previous correspondence upon the subject of an International Bureau of Weights and Measures, I have the honor to inclose herewith for your information a copy of a dispatch (No. 1264, dated December 10)* from the legation of the United States at Paris, with its accompaniments, viz., a communication from General Ibañez, president of the International Committee of Weights and Measures, and a table of the contributions required of each country participating in the establishment and maintenance of such a bureau.

I have the honor to be, sir, your obedient servant,

JOHN L. CADWALADER,
Acting Secretary.Hon. BENJAMIN H. BRISTOW,
Secretary of the Treasury.

No. 51.

Mr. Cadwalader to Mr. Hitt.

DEPARTMENT OF STATE,
Washington, December 28, 1875.

SIR: Referring to your telegram of the 19th instant, in reply to that of the department of the 18th, in which you express your intention, on the 20th instant, to ask for an extension of two months for the exchange of ratifications of the metrical convention, I have to inclose you a copy of a letter from the Secretary of the Treasury of the 17th instant,† and its accompaniment, upon which letter the telegram addressed to you

* See Document No. 45.

† See Document No. 46.

was based. You will perceive that the Secretary of the Treasury names the 20th of March as the extension desired by that department. It is anticipated that although Mr. Washburne had intended to ask the extension at the date fixed for the ratification of the convention, no difficulty will be found in obtaining the required extension, and you are instructed to make known the wishes of the Treasury Department in the proper quarter.

It may be added that the Treasury Department has been informed that the 20th of December was, as is believed, the date informally fixed for ratification.

I am, &c.,

JOHN L. CADWALADER,
Acting Secretary.

No. 52.

Mr. Washburne to Mr. Fish.

No. 1284.]

LEGATION OF THE UNITED STATES,
Paris, February 4, 1876. (Received February 21.)

SIR: Upon the receipt of your instructions No. 770, December 28, 1875, the secretary of this legation communicated to the Duke Decazes the fact that the United States desired an extension until March 20, 1876, of the time for exchanging ratifications of the metrical convention. A letter from the Duke Decazes, in reply, January 31, 1876, assents to the delay requested, which had indeed been provided for at the meeting of the representatives of the powers parties to the convention December 20, 1875.

I have, &c.,

E. B. WASHBURN.

No. 53.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
February 17, 1876.

SIR: Referring to previous correspondence in reference to the metrical convention some time since concluded in Paris, I have the honor to inform you that I have caused a translation, which was submitted to you for approval, to be carefully examined since its return from your Department, and have adopted almost entirely all the modifications suggested in the communication addressed to you from the Bureau of Weights and Measures.

Some few changes have been made with a view of presenting the formal parts of the convention in more perfect translation. I now submit to you a copy of a translation of the entire convention,* which, if requested by you, I will cause to be submitted, with the original, by the President for the action of the Senate.

As the matter in question pertains properly to your department, it is supposed that any information or communication which may properly be made in furtherance of the ratification of the convention, or in reference to legislation respecting the same, will be made from your department. I will thank you to return the translation at an early day with an expression of your views concerning the subject.

I have, &c.,

HAMILTON FISH.

No. 55.

Mr. Bristow to Mr. Fish.

TREASURY DEPARTMENT,
March 6, 1876. (Received March 7.)

SIR: I have the honor to transmit herewith a copy of a letter of the 4th instant, from Mr. C. P. Patterson, Superintendent of the United States Coast Survey, in which he refers to the extension of the time until March 20th instant for exchanging ratifications of the metrical convention by the several governments interested, and suggests,

* See Document No. 1.

with the main view of affording the Senate opportunity for full deliberation upon the subject, a further postponement (but within the limits of the present session of the Senate) of the date for ratifying the convention by our own government.

I have the honor to be, sir, your obedient servant,

B. H. BRISTOW,
Secretary.

HON. HAMILTON FISH,
Secretary of State.

[Inclosure.]

Mr. Patterson to Mr. Bristow.

UNITED STATES COAST SURVEY OFFICE,
Washington, March 4, 1876.

SIR: I have had the honor to receive with Department letter of February 23 notice through the State Department, as made known to the honorable Secretary of State by the American minister at Paris, that the Duke Decazes had officially assented to a proposed extension until March 20, 1876 (instant), of the time for exchanging ratifications by the several governments of the convention which resulted from a previous International Conference in regard to a Bureau of Weights and Measures.

With reference to the near approach of the limit in time, as now appointed (March 20, 1876), for ratification, and in order to afford the Senate opportunity for such deliberation as could not be practicable in the absence of a comprehensive statement of the objects of the convention, which statement, as prepared by Prof. J. E. Hilgard, one of the American delegates at the International Conference, I had the honor to transmit to the Department, under date of March 3 instant, I would respectfully suggest for consideration by the honorable Secretary of State that a further postponement seems desirable of the date (but within the present Senate session) for ratifying the convention by our government.

Very respectfully,

C. P. PATTERSON,
Superintendent United States Coast Survey and Weights and Measures.

HON. B. H. BRISTOW,
Secretary of the Treasury.

No. 56.

Mr. Fish to Mr. Washburne.

DEPARTMENT OF STATE,
Washington, March 8, 1876.

SIR: I herewith transmit to you a copy of a letter from the Secretary of the Treasury, dated the 6th instant, and of its accompaniment, upon the subject of extending the time in which to exchange the ratifications of the metrical convention.

You are requested to effect a postponement of these ratifications to such date as can be obtained, say for sixty or ninety days, if possible.

I am, &c.,

HAMILTON FISH.

No. 57.

Mr. Fish to Mr. Bristow.

DEPARTMENT OF STATE,
Washington, March 9, 1876.

SIR: I have the honor to acknowledge the receipt of your letter of the 6th instant, with its accompaniment, suggesting a further extension of the time within which to exchange the ratifications of the metrical convention; and to inform you that the minister of the United States at Paris has been requested to use his efforts to procure a further postponement to such date as can be obtained.

I have the honor to be, sir, your obedient servant,

HAMILTON FISH.

HON. BENJAMIN H. BRISTOW,
Secretary of the Treasury.

METRIC SYSTEM.

No. 58.

Mr. Washburne to Mr. Fish.

No. 1372.]

LEGATION OF THE UNITED STATES,
Paris, September 21, 1876. (Received October 6.)

SIR: By your dispatch No. 787, of March 8, you instructed me to request an extension of time of thirty or ninety days for the exchange of ratifications of the metrical convention. I have done so, and obtained from the Duke Decazes a delay of ninety days from the 28th of March last.

This delay has expired long ago, and I have received from Dr. Hirsch, the secretary of the International Committee on Weights and Measures, a request to inform the committee if our Senate had approved the convention and what the intentions of our government were in relation to the matter.

As the Duke Decazes and other parties to the metrical convention may at any moment call upon me for the same information, I would be obliged to you to let me know what I am to answer.

I have, &c.,

E. B. WASHBURN.

No. 59.

*Mr. Morrill to Mr. Fish.*TREASURY DEPARTMENT,
October 20, 1876. (Received October 23.)

SIR: I have the honor to acknowledge the receipt of your communication of the 7th instant, inclosing a copy of a dispatch of the 21st ultimo from the minister of the United States at Paris, relating to the expiration of the time for exchanging the ratifications of the International Metrical Convention, and requesting an expression of the views of this department upon the course proper to be taken in the matter.

In reply, I inclose a copy of a letter, of the 17th instant, from the Superintendent of the Coast Survey, whose views upon the subject were requested, in which, alluding to the postponement of action upon the matter by the Committee on Foreign Relations of the Senate at the last session of Congress, he suggests, in view of the probably favorable action in regard to the Metrical Convention by Congress at its next session, that a further extension of time for exchanging the ratifications be secured—say until the 12th of April, 1877; and I have accordingly respectfully to recommend that you will take the proper course to secure, if practicable, an extension of the time for exchanging the contemplated ratifications of the Metrical Convention on the part of the United States until the date above named, with the view to the necessary action being taken in the matter by Congress at its coming session.

The copy of the printed memorial to Congress, in favor of an International Bureau of Weights and Measures, referred to by the letter of the Superintendent of the Coast Survey, as showing the favorable consideration the proposed establishment has received from many eminent and influential citizens, is herewith inclosed.

I have the honor to be, your obedient servant,

L. M. MORRILL, Secretary.

Hon. HAMILTON FISH,
Secretary of State.

[Inclosure.]

*Mr. Patterson to Mr. Morrill.*UNITED STATES COAST SURVEY OFFICE,
Washington, October 17, 1876.

SIR: I have the honor to receive the department letter of October 14, which inclosed correspondence of the Department of State, including a communication from the minister of the United States at Paris, relative to the expediency of asking from the International Committee on Weights and Measures a further extension of the term for the ratification by our own government of the convention for an International Bureau of Weights and Measures.

With reference to peculiar circumstances which retarded the course of ordinary business in the Senate of the United States during the last session, and in consequence of which action in regard to the International Bureau was postponed by the Committee

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of Foreign Relations of the Senate, I would respectfully suggest that the honorable Secretary of State be requested to secure a further extension of time, sufficient to cover the action of Congress at the next session—say until the 12th of April, 1877.

The convention will most probably be ratified at an early date in the next session, and there is no reason to suppose that objection will be made in the House of Representatives to the small appropriation requisite for carrying the convention into effect. That the proposition has been well considered is shown by the accompanying copy of the memorial to Congress from universities, colleges, manufacturers, bankers, and intelligent citizens of all pursuits throughout the several States of the Union.

The State Department letter of October 7, and letter of Minister Washburne, dated September 21, are herewith returned.

Very respectfully yours,

C. P. PATTERSON,
Superintendent United States Coast Survey and Standard Weights and Measures.
Hon. LOT M. MORRILL,
Secretary of the Treasury.

No. 60.

*Mr. Cadwalader to Mr. Washburne.*DEPARTMENT OF STATE,
Washington, October 25, 1876.

SIR: Referring to your No. 1372 of the 21st ultimo, relating to the expiration of the time for exchanging the ratifications of the International Metrical Convention, and to the expediency of asking a further extension for the ratification by this government of the convention, I have now to inclose a copy of a letter of the 20th instant, and of its accompaniments, from the Secretary of the Treasury, to whom the matter was referred, and to request that, pursuant to the suggestion contained therein, you will do what you possibly can toward effecting a further extension of time until the 12th of April, 1877, in order that proper action may be taken thereon by Congress at its ensuing session.

I am, &c.,

JOHN L. CADWALADER,
Acting Secretary.

No. 61.

*Mr. Washburne to Mr. Fish.*LEGATION OF THE UNITED STATES,
Paris, November 15, 1876. (Received December 2.)

SIR: In compliance with the instructions contained in your No. 844, I have the honor to state that I have made the necessary application for a further extension of time, until April 12, 1877, for the ratification of the Metrical Convention, and that on the 14th instant the Duke Decazes informed me he would communicate my request to the governments which have signed the convention.

I have, &c.,

E. B. WASHBURN.

No. 62.

*Mr. Noyes to Mr. Evarts.*LEGATION OF THE UNITED STATES,
Paris, January 15, 1878. (Received January 31.)

SIR: I have the honor to send herewith, to be transmitted to the proper quarter, the following documents received from the International Committee of Weights and Measures, sitting at Neuchâtel, Switzerland, viz:

1. Three copies of the committee's first report to the governments parties to the International Metrical Convention.*
2. A circular of General Ibáñez, president of the committee, in relation to the same matters.
3. A circular of Mr. Hirsch, secretary of the committee, giving the proportion of expense incumbent upon each government for the working of the International Bureau of Weights and Measures during the year 1878.

I have, &c.,

EDWARD F. NOYES.

*A large pamphlet, not printed herewith.
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[Inclosure 1 in No. 62.—Translation.]

General Ibañez to Mr. Noyes.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES,
Madrid and Neuchâtel, January 12, 1878.

Mr. MINISTER: In the name of the International Committee of Weights and Measures, we have the honor to send to your government, through your excellency, three copies of the first "Report of the International Committee of Weights and Measures to the governments signing the metrical convention."

The minutes of the last session of the international committee are at present in press, and we will hasten to transmit them to the governments as soon as they are published.

Accept, sir, &c.,

GENERAL IBÁÑEZ, President.
DR. AD. HIRSCH, Secretary.

[Inclosure 2 in No. 62.—Translation.]

General Ibañez to Mr. Noyes.

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES,
Madrid and Neuchâtel, December 15, 1877.

Mr. MINISTER: The International Committee of Weights and Measures, in exercise of the right conferred upon it by article 6 of the regulations annexed to the metrical convention, has decided, at its sitting of September 21st ultimo, to fix the annual budget of the International Bureau of Weights and Measures for the year 1878 at 100,000 francs.

In pursuance of this decision, and conformably with article 9 of the convention and article 20 of the regulations annexed to the convention, prescribing the distribution of the expenses of the bureau among the contracting states, we have established, on the same basis as before, the annexed table of the contributive shares for the account of 1878.

It appears from this table that the contributive share of the United States for the year 1878 amounts to 9,714 francs.

Conformably with article 10 of the metrical convention, we have the honor to request your excellency to be pleased to pay, at the commencement of the coming year, the contributive share of the United States to the Ministry of Foreign Affairs of France.

Accept, sir, &c.,

GENERAL IBÁÑEZ, President.
DR. AD. HIRSCH, Secretary.

[Inclosure 3, No. 62.]

Table of the shares to be contributed by the several states for the International Bureau of Weights and Measures for the year 1878.

Contracting states.		Population.	Co-efficient.	Factor of distribution.	Annual expenses 100,000. Unit, 124,53 francs.
1	Germany	41,010,150	3	123	Fr. 15,318
2 a	Austria	20,136,233	3	60	7,472
2 b	Hungary	15,505,575	3	47	5,853
3	Belgium	5,253,821	3	16	1,992
4	Argentine Confederation	2,000,000	2	4	498
5	Denmark	2,000,000	1	2	249
6	Spain	24,236,590	3	73	9,091
7	United States of America	38,925,598	2	78	9,714
8	France	40,943,120	3	123	15,318
9	Italy	26,801,154	3	80	9,963
10	Peru	2,500,000	3	8	996
11	Portugal	5,400,000	3	16	1,992
12	Russia	76,500,000	1	77	9,589
13 a	Sweden	4,341,559	1	4	498
13 b	Norway	1,795,000	2	4	498
14	Switzerland	2,669,147	2	5	1,235
15	Turkey	39,000,000	2	78	9,714
16	Venezuela	1,784,194	3	5	623
Total.....		350,805,191	.....	803	100,001

METRIC SYSTEM.

No. 63.

Mr. Noyes to Mr. Evarts.

No. 63.]

LEGATION OF THE UNITED STATES,
Paris, February 22, 1878. (Received March 9, 1878.)

SIR: I have the honor to transmit herewith a translation of a letter that I have received from General Ibañez, president of the international commission of weights and measures, and a statement of the financial situation of that commission. The matter is so fully explained and the whole subject discussed with such fairness that I will only add the remark that it seems to me that there is urgent need of some definitive decision by the United States in regard to the metrical convention, which we have been holding under consideration for nearly three years.

I have, &c.,

EDWARD F. NOYES.

Hon. WILLIAM M. EVARTS,
Secretary of State.

[Inclosure 1, No. 63—Translation.]

INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASURES,
Madrid and Neuchâtel, February 15, 1875.

SIR: We have the honor to send to your excellency a memoir containing a statement of the financial situation of the International Committee on Weights and Measures, and intended to furnish to the governments of the high contracting parties to the metrical convention information in regard to the special causes which have led to the decision of the committee to raise the sum of estimated expenses for the current year to 100,000 francs.

It appears from this statement that the delay on the part of the United States to ratify the convention of the 20th of May, 1875, has contributed largely to create the financial situation of the international establishment founded by the metrical convention which it has become our duty to signify to the contracting governments in order to cover our responsibility.

Not knowing the causes which have led to this delay, the international committee continue to hope that the great American Republic, maintaining its participation in the metrical convention, will also be willing to contribute, in company with most of the civilized nations, to the support of an international work of great practical and scientific utility, and to facilitate the general use of a rational and scientific system of weights and measures, which has a great number of adherents in the United States. In the interest of the general progress of the sciences of industry and of commerce wherein the United States takes so eminent a part, it would be greatly to be regretted if the Anglo-Saxon world determined to maintain definitively a separate position in regard to weights and measures, when all the other nations are tending more and more to facilitate their relations by adopting and perfecting a single system of weights and measures. These reasons, which doubtless inspired the Government of the United States when it took part in the metrical convention, will, we venture to hope, determine the superior authorities of your country to ratify this convention.

We would be particularly obliged to your excellency if you would kindly inform us of the definitive decision which will before long be reached at Washington, and which the other contracting countries are interested to know at the earliest possible moment.

Please accept, sir, the assurances of our highest consideration.

GENERAL IBÁÑEZ, President.
DR. AD. HIRSCH, Secretary.

[Inclosure 2, No. 63]

INTERNATIONAL COMMITTEE OF WEIGHTS AND MEASURES.
Statement of the financial situation of the International Committee of Weights and Measures.

In the circular of December 15, 1877, by which the bureau of the International Committee of Weights and Measures had the honor to communicate to the governments of the contracting states a table of the contributions necessary for the term of 1878, reference was made to the report required by the regulations to be issued at the same time, in order to explain the decision of the committee to fix the budget of the present year at one hundred thousand francs.

In consequence of unforeseen circumstances the printing of the report has been de-

layed for some weeks, so that it could not be issued earlier than the 12th of last January. The issue of the volume containing the protocols of the last session of the international committee, wherein the reasons of its decision are explained, being also delayed in consequence of the printing of the scientific memoirs annexed to that volume, the bureau of the committee deems it its duty to give to the governments of the high contracting parties, by means of the present communication, an explanation of the motives which decided the committee to exercise the right conferred upon it by article 6 of the regulations annexed to the metrical convention.

We take advantage of this opportunity to present at the same time to the contracting governments an exposition of the financial condition of the international committee, caused by the delays experienced in the payment of a considerable part of the contributions provided for by the convention of May 20, 1875.

The committee is required by the convention to apportion the expense of establishing the international bureau, as well as the annual expenses thereof, among the signatory-states of the metrical convention. Two of them, however, the United States of America and Venezuela, have not yet ratified the convention, and consequently have not yet paid their shares for the terms of 1876 and 1877; and even if, as we take pleasure in hoping, the ratification be effected this year, the payment of the overdue contributions will probably not be performed by those two states until 1879.

On this account the resources of the committee have been diminished by the following sums:

Years.	Due from	Due from	Total.
	the United States.	Venezuela.	
1876			
	Francs.	Francs.	Francs.
1877	46,143	2,958	49,101
	7,285	467	7,752
1878	9,714	623	10,337
	63,142	4,048	67,190

Moreover, among the states which have ratified the convention, Peru has not yet paid her share for the terms of 1876 and 1877, amounting to 5,479 francs, nor Turkey her share for 1877, amounting to 7,285 francs, which produces an arrearage of 12,764 francs.

The committee is consequently short to the extent of 79,954 francs, upon which sum, however, it had a right to count in the preparations and arrangements it has made for the erection and organization of the international bureau. It was not in the option of the committee to demand from the contracting governments that the deficit should be apportioned among them *pro rata* according to the scale fixed by the convention, so long as the two above-named states had not definitely refused to ratify that instrument, and before being officially informed that the payments due from Turkey and Peru had not been made at the "Caisse Dépôts et Consignations," at Paris, up to the end of 1877.

The international committee, being in this way deprived of a considerable part of the resources assured to it by the convention of May 20, 1875, now finds itself in a financial position of some difficulty, which, even though temporary, creates serious embarrassment, seeing that the committee is called upon to meet in the course of this year the engagements it has entered into with the contractors and constructors of the buildings and instruments for the International Bureau of Weights and Measures, and that it must besides provide for certain supplementary expenses for the completion of the buildings. In consequence of these circumstances, the committee is obliged to postpone until next year all expenses not absolutely necessary, and among others to delay the order for several important instruments.

But, even with the strictest economy, the committee could not meet all its obligations for 1878 had it not taken the precaution to increase the budget for that year to 100,000 francs, which would most assuredly not have been necessary if the 80,000 francs of contributions due had not failed it.

Indeed, the committee, on accounts, in presenting its report to the international committee at its meeting of September 15, 1877, stated that at that time only the sum of 59,021 francs remained available. It was in view of this state of affairs that the director of the international bureau, at the meeting held September 21, offered the following resolution:

"Whereas article 6 of the regulations annexed to the convention of May 20, 1875, provides that 'the annual budget of the bureau can be modified, according to circumstances, by the international committee, on motion of the director, but without at any time exceeding the sum of 100,000 francs.'

"Considering that the sums already pledged for the payment of works of construction and apparatus for heating and ventilation, for furniture, for the purchase of instruments, &c., &c., and in addition thereto, the salaries of the employés of the bureau, will absorb to a great extent the available funds; and

"Considering that there will still be other expenses to be incurred for alterations of certain portions of the buildings, in conformity with the suggestions of the committee, which are necessary to allow of the introduction of gas and water into the establishment—

"I have the honor to propose to the committee that the annual budget for the year 1878 be raised from the sum of 75,000 francs to the sum of 100,000 francs."

This resolution was unanimously adopted by the committee.

In order to show to what an extent this precaution was necessary, if the committee did not wish to be exposed to the chance of not being able to meet its indispensable expenses, we beg leave to submit herewith a synopsis of the budget for the year 1878, as well as it could be prepared according to the data available on the 31st of December, 1877, and reserving details for the next regular report:

RESOURCES.

	Francs.
Balance at the "Caisse des dépôts et consignations" December 31, 1877	117,447
Balance at the banker's, same date	11,816
Receipt of contributions for 1878, francs	100,000
Deduction made on account of the United States	9,714
On account of Venezuela	623
	10,337
Probable interest from the "Caisse"	89,663
	1,000
Total francs	219,791

EXPENSES.

	Francs.
I. Regular annual expenses:	
a. Salaries of employés, francs	26,000
b. Maintenance, purchase, and repair of apparatus, heating, lighting, &c., francs	24,000
	50,000
II. Contracts, payable in 1878, for buildings and instruments	113,038
III. Supplementary expenses for completion of work now in construction, about	56,000
Total	219,028

It results from this statement of the financial condition that, even counting on the receipt of all the contributions of the states which have ratified the convention, the means at the disposal of the committee for 1878 will be only strictly sufficient to cover the unavoidable expenses.

In conclusion, the bureau of the committee must express its firm hope that this precarious state of things will be remedied by next year, when the question of the ratifications will be definitely settled, and all arrears shall have been paid; and it feels enabled to affirm that, in then having at its disposal the 80,000 francs hitherto in default, the committee will be in a condition to satisfy all the requirements for the execution of the duties confided to it by the governments of the high contracting parties.

Madrid and Neuchâtel, February 7, 1878.

General IBÁÑEZ, President.

Dr. AD. HIRSCH, Secretary.

No. 64.

[Translation.]

Mr. Outrey to Mr. Evarts.

LEGATION OF FRANCE IN THE UNITED STATES,
Washington, March 6, 1878.

Mr. SECRETARY OF STATE: The Government of the United States, which signed the convention of May 20, 1875, in relation to the establishment of an International Bureau of Weights and Measures, has found itself obliged, by reason of parliamentary necessities, to ask for successive delays for the ratification of that convention.

The last communication addressed to the French Government on this subject by the minister of the United States at Paris bears date of November 8, 1876. At that time, Mr. Washburne, stating the reasons which had prevented the Senate until then from giving its attention to the question of the metre, asked that the exchange of the ratifications might again be adjourned until after the ensuing session of Congress. He added, moreover, that there was every reason to hope that the Senate would approve this convention, which had been recommended to its examination by a petition of the universities, the manufacturers, the bankers, and a large number of the distinguished men of this country.

Since that time my government has received no communication on the subject, and the question of the ratification by the Federal Government of the convention concerning the metre is still undecided.

Under these circumstances the International Committee on Weights and Measures has addressed a letter to the Minister of Foreign Affairs, in which it sets forth all the inconveniences resulting from this situation. It is a matter of importance for it, as the buildings for the international bureau are quite far advanced in course of construction, to know whether it can depend upon the co-operation of the United States, or whether it must divide their share of the expense for the fiscal years of 1876, '77, and '78 among the other contracting powers.

Mr. Waddington, in instructing me to make known to you the request of which I have the honor to inclose a copy, expresses a desire to be informed concerning the intentions of the Washington Cabinet on this subject.

I shall be very grateful to you, Mr. Secretary of State, if you will be pleased to enable me to reply to the question addressed to me by the Minister of Foreign Affairs; and I gladly avail myself of this occasion to reiterate to you the assurances of my very high consideration.

MAX OUTREY.

[Inclosure.—Translation.]

General Ibañez to Duke Decazes.

INTERNATIONAL COMMITTEE ON WEIGHTS AND MEASURES,
Madrid and Neuchâtel, February 6, 1878.

MR. MINISTER: Among the states which signed the convention relating to the metre, there are two, the United States of America and Venezuela, that have not yet ratified the convention which they signed on the 20th of May, 1875.

It is not within the province of the international committee to set forth the reasons to the governments of these two states which should induce them to leave the other contracting states no longer in uncertainty as to their definitive adhesion.

The international committee, however, which has charge of the execution of the convention, finds itself under the necessity, in order to accomplish its task, of obtaining from the governments interested a speedy solution of this question. The delay in ratifying on the part of the two states aforesaid has deprived the committee of a considerable part of the resources secured to it by the convention, on which it has been obliged to rely in the engagements which it has made for the construction and organization of the International Bureau of Weights and Measures, and it will not be possible to divide the deficit among the other contracting states, according to the rules adopted by the convention, until the question of the ratification of these two states shall have been decided.

Now, the committee being obliged to settle the accounts for the building of the international bureau in the course of the present year, should be enabled to dispose of this portion of its resources.

These considerations have led the international committee to beg the French Government, which has taken charge of the exchange of the ratifications, to be pleased to endeavor to induce the Government of the United States and that of Venezuela to ratify the convention of May 20, 1875, as speedily as possible, and, as a consequence, to pay the contributions due for the fiscal years of 1876, '77, '78, or at least to come to a definitive decision, which will enable the contracting governments to regulate the situation of the scientific establishment which they have founded in common.

The international committee will be grateful to your excellency if you will inform it, with as little delay as possible, of the result of the steps which the French Government may see fit to take, in order that the committee may be able to adopt in time such measures as may be demanded by its financial situation.

Be pleased to accept, &c., &c., &c.

General IBANEZ, President.
Dr. AD. HIRSCH, Secretary.

To his Excellency the Minister of Foreign Affairs at Paris.

No. 65.

Mr. Evarts to Mr. Outrey.

DEPARTMENT OF STATE,
Washington, March 25, 1878.

SIR: I have the honor to acknowledge the receipt of your note of the 6th instant, and the copy, which accompanied it, of a communication addressed to the Minister of Foreign Affairs of France by the International Committee on Weights and Measures relative to the apparent delay which has occurred on the part of the Government of the United States in ratifying the metrical convention of May 20, 1875, and requesting to be informed as to the intentions of this government in connection therewith.

In reply I have to state that on the 10th of March, 1876, the President submitted for the consideration of the Senate, with a view to its ratification, the metrical convention, together with certain papers therein referred to. The matter is still pending before that body, no action having been taken thereon.

The attention of the proper committee of Congress will at once be recalled to the matter.

Accept, sir, &c.,

Mr. MAXIME OUTREY, &c., &c., &c.

WM. M. EVARTS.

No. 66.

Mr. Evarts to Mr. Noyes.

DEPARTMENT OF STATE,
Washington, March 27, 1878.

SIR: Referring to your No. 63, of the 23d of February last, relating to the international metrical convention of May 20, 1875, I have to inform you that, under date of 10th March, 1876, the President submitted for the consideration of the Senate, with a view to its ratification, the metrical convention, together with certain papers upon the subject. As no action in the matter has been taken by that body, the attention of the proper committee of Congress has recently been called to the subject, in order that a prompt decision may be reached as to the action of this government.

I am, &c.,

WM. M. EVARTS.

No. 67.

Mr. Sherman to Mr. Evarts.

TREASURY DEPARTMENT,
March 29, 1878.

SIR: The statement of the president and secretary of the International Metric Committee, inclosed with your letter of the 16th instant in regard to the financial embarrassment of the committee, which they attribute in a large degree to the delay of the United States to ratify the international metric convention of May 20, 1876, was transmitted by this Department to the Superintendent of Weights and Measures.

A communication dated the 27th instant, a copy of which is herewith inclosed, has been received in reply from Mr. Carlisle P. Patterson, Superintendent of the United States Coast Survey and of Weights and Measures, stating that the metric convention, having been sent to the United States Senate and referred to the Committee on Foreign Relations, has not yet been acted upon, and suggesting that the honorable the Secretary of State be requested to call the attention of the Senate or of its committee above named to the fact that the convention still remains undisposed of, and that the other contracting parties are awaiting a decision.

I have respectfully requested that the proper representations may be addressed to the Senate, agreeably to the desire expressed in the letter of the Superintendent of Weights and Measures.

Very respectfully,

JOHN SHERMAN,
Secretary.

[Inclosure.]

Mr. Patterson to Mr. Sherman.

BUREAU OF WEIGHTS AND MEASURES,
UNITED STATES COAST SURVEY OFFICE,
Washington, March 27, 1878.

Sir: In reply to your letter of yesterday's date, relative to the convention for an International Bureau of Weights and Measures, I have the honor to inform you that said convention was sent to the United States Senate in March, 1876, referred to the Committee on Foreign Relations, and has not yet been acted on.

This office has never lost sight of the matter, as the project is highly approved by me, and its consummation desired. An item for the probable pecuniary obligation arising from the ratification of the convention has annually been inserted in the estimates for appropriations.

The natural course to pursue in the premises would seem to be that the honorable Secretary of State call the attention of the Senate, or of its Committee on Foreign Relations, to the fact that this matter remains undisposed of, and that a decision is desired by the other contracting parties.

Very respectfully,

C. P. PATTERSON,
Superintendent of Weights and Measures.

The papers are herewith returned.

Hon. JOHN SHERMAN,
Secretary of the Treasury.

CHAPTER V.

COMMUNICATIONS, STATUTES, AND TABLES.

Letter from President F. A. P. Barnard to C. P. Culver, clerk of the Committee on Coinage, Weights, and Measures.

COLUMBIA COLLEGE, PRESIDENT'S ROOM,
New York, December 9, 1878.

DEAR SIR: I was absent from the country at the time your letter of last spring was received here; and on my return, I supposed it would be too late for me to reply to you for any useful purpose. You requested me to make any suggestion or furnish any information which might occur to me in connection with the subject of the expediency of introducing into this country the metric system of weights and measures.

I do not know that I can contribute much to what I have already said, and what others have said, in print on this subject; but since my return I have seen the printed replies of the officers of the Treasury Department and of the War Department to the questions of the committee, and I should like to say a word or two in regard to some of these.

In the first place, however, I wish to say that I have not seen any replies to your committee, except those just mentioned, from the Departments of War and the Treasury. If there have been received other printed responses, I should esteem it a great favor if you would send me copies.

I wish to say in regard to the remark of our friend Mr. Hilgard, to the effect that in estimating the extent to which the metric system has been already introduced, it is not at all to the purpose to count the Republics of Central and South America, because the people of those countries are in general peasants and herders, who use no measures at all—though I am sure that Mr. Hilgard is not unfriendly to the proposed metric reform—I am confident he does not perceive the fallacy involved in this suggestion of his. If the measure we propose were one of the results of which we ourselves could expect personally to see, his objection would have more weight; but, inasmuch as our legislation is not for this, but for *future* generations, it is a very great thing to know that the peoples occupying portions of the planet which nature has marked as likely to be among the most populous, and most productive, and probably hereafter most advanced in the arts of all the human race, are destined by actually completed legislation to make use of that system of weights and measures which now prevails over nearly all the continent of Europe. The same remark may be made of India, where neither the metric system of weights and measures, nor any other, is generally prevalent, but where, on the other hand, the confusion is of a most perplexing character. The British Government and the Indian Government have seen that the only true way out of this perplexity is to sanction the metric system, and to provide that it shall be in due and judicious time legally enforced. This being the case, it is of very little consequence to the real object we have in view (which is the future of the world in regard to metrology), that neither the South American States nor the East Indies now generally use the metric system, or any other system. The *certainty* that they are going to use them, is an argument of immense force in its relation to the real question before us.

There is another assumption on which I wish to comment for a moment, which I find, in two places at least in these replies. One of these places is in the report of Mr. Upton, who is entirely friendly to the measure we propose, and the other is in the reply of General Meigs, who is intensely hostile to this measure. Both of these gentlemen say that the meter has been "ascertained not to be the ten-millionth part of the Paris meridian." General Meigs says "it has been ascertained that the meter bears no relation to that quadrant." Mr. Upton says, "it has been demonstrated that the length of the quadrant of the meridian was not accurately ascertained." I am astonished at the positiveness of these assertions. Nothing of the kind has been either demonstrated or ascertained. On the other hand, I think that the evidence is altogether in favor of the accuracy of the determination made by the great French geodetic commission. I do not, indeed, think it possible in the present state of science, to determine with *positive* exactness the length of any quadrant of any meridian; but I do think it possible to determine that length within a limit, which shall leave room for no *sensible* error; and

that I believe was done in the case of the French meridian. What has been "ascertained" is that the earth is not regular in its figure. The speculations of Mr. Bessel, Professor Airey, and General de Schubert were founded upon a hypothesis which they pleased to assume to be true for the purpose of their calculations. They assumed that the earth, though not a sphere, nor a flattened spheroid, was, nevertheless, a regular geometrical ellipsoid of three axes. If anything has been proved by the surveys, it is that their hypothesis is a mere fancy. It follows that the most probable result to be obtained in endeavoring to determine the length of a meridian must be derived *from actual measurement on the meridian itself*. The mathematicians I have mentioned made inferences as to the Paris meridian by arguing from measurements on other meridians, as in Russia, India, and South America, on the supposition that the earth has a regular geometrical figure.

Assuming as a basis such a hypothesis, that is to say a supposition of the truth of which we have no sufficient evidence, and which in all probability is not true, there is no sort of anomalous result which cannot be worked out when you attempt to combine the measurements of different meridian arcs with each other for the purpose of inferring the earth's figure, on the supposition that such figure is geometrical. Colonel Everest, the accomplished director of the Indian survey, by similar combinations obtained about seventy-seven different results, all giving different equatorial and different polar diameters.

This fact alone shows the absurdity of trying to deduce the length of the arc of the Paris meridian by mathematical deductions from the measurements of meridians elsewhere. In the present state of science, as I have said before, the surest way of finding a result approximating the length of any given meridian is to make the measurement on that meridian itself; and that is what the French commission did. I suppose an able commission was never employed in similar work anywhere.

The publication in this country and wide circulation (through a shrewd scheme of the late Professor Davies to scatter his crude views at the expense of the State of New York) of Sir John Herschel's lecture on the metre, the yard, and the pendulum, has given to the speculations of Airey and de Schubert a notoriety among us which Colonel Everest's no less able and far more comprehensive computations have not attained. This lecture, though bearing the mark of Herschel's great ability, is nevertheless, in my view, very little creditable to his judgment; and deserves by no means the amount of consideration which some have been disposed to give it. But the thing which astonishes me most in this matter is that men of education, and men highly esteemed as men of science, should, at this day, so little understand this question as to say that there has been anything "demonstrated" to invalidate the accuracy of the established base of the metric system. I hope therefore the report of your committee, whatever may be the conclusions of the committee in regard to legislation recommended or discouraged, will not lend its sanction to a statement so entirely unfounded as that which I have referred to as disfiguring the otherwise able replies to the committee from the chief clerk of the Treasury Department, and from the office of the Quartermaster-General.

I am, very truly, yours,

F. A. P. BARNARD.

THE ADOPTION OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES FOR MEDICAL AND PHARMACAL PURPOSES BY THE UNITED STATES MARINE HOSPITAL SERVICE.

(Being a report to Surgeon-General John M. Woodworth, revised and reprinted from his annual report for 1877, with additions by the author.

BY OSCAR OLDBERG, Phar. D.,
Chief Clerk and acting Medical Purveyor, United States Marine Hospital Service.

WEIGHTS AND MEASURES—THE OLD AND THE NEW.

The disadvantages of the inharmonious systems of weights and measures still in use in the United States, Great Britain, and other countries, and the advantages, on the other hand, of a uniform and harmonious international or universal system of measurement of distance, surface, volume, weight, and value are familiar.

The early introduction, however, of the French decimal system, based on the *meter*, as the best yet devised, meets with warm, if not successful, opposition, although it is, perhaps, generally admitted that the final and complete adoption in the United States of the metric weights, and measures, provided we prepare for it, will sooner or later certainly come. Our coinage, fortunately decimal, closely approaches a comparatively simple numerical relation to the metric unit of weight—the one-dollar gold piece weighing (within 3 per mille) one and two-thirds grams, and consequently the three-dollar gold piece, five grams (within 3 per mille). It is believed that the government not only could, but ought to aid the people in learning to know and use the metric system, which might be done in various ways. An effort to compel its immediate adoption by the people would probably prove futile, or productive of great evil; but the agents of the government might well be expected and required to employ that system exclusively in certain official transactions, and it should be thoroughly taught in the public schools, in order that its simplicity and practical superiority may be demonstrated. Whether, however, the introduction of the metric system for general purposes, already legalized, be near or distant, and whether the supposition that its use will soon by the Congress be made obligatory on the part of the officers of the government be correct or not, I am quite confident that the present is as good a time as any for the adoption of metric weights and measures for professional purposes.

By way of illustration, I may here briefly refer to some of the reasons upon which the proposed rejection of the apothecaries' weights and measures and the preference for the decimal metric system are based.

As the different systems and standards in use prior to the construction of the metric system, or afterwards adopted and still largely used, were not derived from any constant quantity in nature, while others have been contrived which are compromises between the old and the new, we find upon a comparison of the multifarious pounds and their subdivisions, and of the various grains upon which they were originally based, that the term "pound" is applied to quantities equal to 500 grams, 453.59 + grams, 425 grams, 373.25 — grams, or 357.66 + grams, &c., as the case may be; and that the term "grain" is applied to quantities varying from 0.045 — to 0.073 + grams, the difference between the largest and the smallest "grain" exceeding fifty per cent. In some countries the pound is subdivided into 16 ounces; in others, into 12 only. Sometimes the ounce contains 16 drachms; at other times only 8. One ounce means 480 grains; another 437½ such grains; another again 480 grains of a different value. One scruple consists of 20 grains, and another of 24. One pound contains 7,200 grains, and other pounds, respectively, 7,000, 6,912, and 5,760 grains. Finally, two or more systems, resembling each other chiefly in their arbitrary and complex character, are simultaneously used in the same country. Even the term "minim," though used only in Great Britain and the United States, is applied to different quantities. Add to these conflicting terms, subdivisions, and values the further fact that our existing units of weight and measure bear no simple relation one to the other, having been originally fixed without reference to each other.

The essential characteristics of a system of weights and measures which may entitle it to cosmopolitan adoption as superior to the old arbitrary and incongruous systems,

or rather no-systems, are: 1st. That it rest upon a basis of some geographical magnitude; 2d. That it be a decimal system (our arithmetic being decimal); 3d. That the unit for linear measurement be the primary unit of the whole system, to which the units for measurement of surface, volume, and weight, derived from it, shall bear the simplest relation possible. These conditions are fulfilled by the metric system, based upon the meter.

The changes requisite in order to bring about simple numerical relations between the units of our weights, measures, and coinage and the metric units are comparatively slight, and various propositions have therefore been made to that end. The temptation to try to utilize the merits of the metric system without abandoning the old seems to have been great and general. The metric system has been almost universally recognized as the basis upon which will be established any future systems that may be used, should that system itself not be adopted, and intermediate systems have been constructed accordingly, perhaps chiefly to prepare the way for the meter, the liter, the gram, &c., but sometimes to insure a simple international correlation only, the importance of which is of course conceded by every one. But we are accustomed to think that the familiar units in which we express quantities in our daily business denote such quantities of the ordinary commodities as are generally considered to be the most convenient in supplying our common wants—a proposition which does not bear reflection. We are, moreover, able to fix in our mind the approximate bulk of a certain quantity by weight of any given commodity, or the weight of a certain volume of another, and so we dislike to give up our "gallon," "pint," "minim," our "pound," "ounce," and "grain," &c., unless we can get some other units nearly resembling these in value, or at least familiar to us. The decimal system also encounters opposition from many who would prefer to be able to count the fractional parts of the units by halves, quarters, eighths, sixteenths, thirty-seconds, and sixty-fourths. The difficulties, therefore, in the way of a general and exclusive adoption by the people of an entirely new system of weights and measures—even as simple, rational, and labor-saving as the metric system—are quite formidable. In several countries, and even in France itself, compromise systems have been tried, the units of which were simple multiples of the gram with decimal subdivisions.

Professional men are as well prepared for the adoption of the new metric system now as they ever will be, and as they become familiar with it and apply it daily they will necessarily help to educate others into a proper appreciation of its simplicity. Probably the greatest obstacle in the way of the change is the unwillingness of some to practically ascertain for themselves the degree of difficulty attending it. That we cannot make the new system our own without some preparation, some effort, is obvious enough; but surely every professional man ought to be willing to make the comparatively insignificant sacrifice of time and labor requisite to this end.

The present adoption by the practitioners of medicine and pharmacy of metric weights and measures is entirely practicable and advantageous. In the pharmacopias of Germany and Sweden, and other countries where the metric system is not in general use, nor even legalized for general purposes, the gram has been made the official weight unit, and the use of the old units by pharmacists forbidden, the inconvenience occasioned by the change being found quite inconsiderable. In both countries just named the transition stages were provided for by the introduction of intermediate decimal systems bearing simple relations to the gram; but the utility of such mixed systems is doubtful. Those directly interested—the pharmacists—would, at least by the light of experience, have preferred an immediate change; and the fact that an intermediate system, differing but slightly from either the old or the new, is so readily constructed and used is itself sufficient proof that the disturbance produced in the practice of intelligent professional men by a direct change from grains to grams is not so great as might be supposed.

The principal objection to a change of weights and measures, in the practice of medicine and pharmacy, seems to be, however, that we cannot, without considerable difficulty, dissociate in our minds the dose of any medicinal agent from the troy grain or minim, because doses are a matter of mere memory, we have learned them by heart in those terms, and we must put aside the knowledge already acquired and learn something else in its place. It is urged that old practitioners cannot or will not be prevailed upon, and should not even be expected, to use new units, terms, or denominations of quantity in their prescriptions. They will continue, it is said, to write ounces, drachms, scruples, and grains; and fluid ounces, drachms, and minims. But this, if true, does not seem to be sufficient cause for rejecting the good for the bad. Changes of weights and measures have often been brought about, and units of weight or measure have undergone change of value even without a change of name, which is infinitely more confusing, and yet no great disturbance is spoken of as having taken place in connection therewith. The younger men, it would seem, can very well afford to take this risk, and even do all the work there is to be done. Let those who are unable to follow them be borne along, and leave the unwilling ones to their choice. It is easy enough, as I will presently endeavor to show, to translate ounces, grains, &c., should prescriptions continue to be written in those

terms, into terms of the metric system. The experience, moreover, of those who have used the metric system of weights at all has been that it does not require much practice to be able to think of 2 grams of ipecacuanha, or of 0.002 gram of strychnia, as representing certain volumes and doses, without first translating these expressions into about 30 grains, and $\frac{1}{2}$ grain, respectively. The same is true of measures. In the writer's experience a moderate familiarity with the use of metric weights and measures may be readily acquired.

A general adoption in American and English works on *materia medica* of the terms of the metric system, side by side with those of the apothecaries' weights and measures in stating the doses of medicines, would greatly facilitate the general adoption of the former in practice.

There is good reason to hope that the pharmacopeial convention which is to meet in 1880 to provide for the sixth revision of the pharmacopæcia of the United States will recognize the superiority of the metric system and adopt it for use in that work. The late Assistant Surgeon B. F. Craig, of the United States Army, offered in the pharmacopeial convention of 1870 a resolution instructing the committee of revision "to include some part of the metrical system in the list of officinal weights and measures." Dr. Craig stated to the writer that his preference was for the introduction of the "decigram" as the unit most nearly resembling our troy grain, one decigram being, for the purposes of the practitioners of medicine and pharmacy, practically equivalent to $\frac{1}{2}$ grains. The resolution was passed, but the instruction was not carried out, though no reason is given by the committee for ignoring it. Should the next convention decide to adopt the metric system, it is, therefore, to be hoped that the terms "gram" and "centigram" alone may be sanctioned as the official units of weight, and the term "cubic centimeter" as the official unit of measure, if any. The adoption of more than two units for either weights or measures should be carefully avoided. The writer, for one, believes that all quantities in medicine and pharmacy should be determined by weight, and that measures should be discarded; but so long as cupfuls, tablespoonsfuls, teaspoonsfuls, and drops are prescribed, there is probably no hope for such a radical innovation, although it has many strong advocates.

The time and labor which would be saved in computation and accounts by the adoption of the metric system cannot be but a powerful argument in its favor. This saving is, of course, the same as the saving of time and labor effected by the substitution of dollars and cents for pounds, shillings, pence, and farthings. To find the value of any number of grams of any article, the price per avoirdupois pound being known, is a very simple process. Multiply the number of grams with the price per avoirdupois pound, and then divide the product by 43.6, the number of grams in the avoirdupois pound. This process is certainly not more difficult than the computation constantly found necessary in preparing invoices in which the quantities are expressed in pounds, ounces, drachms, and grains. For the sake of greater clearness, I may be pardoned for quoting an example: 100,000 grams of potassium iodide are to be priced; the manufacturers' quotation is \$3.10 per avoirdupois pound; to find the total value of 100,000 grams at that price, multiply the 100,000 by 3.10 and divide the product, 310,000, by 43.6, which will give the quotient \$683.42 as the answer sought. This answer is correct within one and one-fourth cents, the exact amount being \$683.434. In the same manner the exact value of any number of grams of any article may be computed from the price per avoirdupois ounce by multiplying the number of grams by the ounce price, and then dividing the product by 28.35, the number of grams in one ounce avoirdupois.

Another and still readier method of computing the value of any article per kilogram (1,000 grams), the avoirdupois pound price being known, is to simply multiply the latter by 2.2, the answer arrived at by this rule being too small by only $\frac{1}{10}$ of a cent for every \$1,102.71, or 20.96 cents for every \$100, or about one-fifth per cent. This rule is based upon the fact that one kilogram is equal to 2.20462125 avoirdupois pounds or 15,432.34874 troy grains.

To find the value per meter of any article, the price per yard being known, it is only necessary to multiply the yard price by 1.1 (or to add 10 per cent., which amounts to the same thing), the answer arrived at by this rule being too small by only about three-fifths per cent., or 63 cents for every \$100. Equally easy rules may be constructed in other cases.

With reference to the use of the metric weights and measures in prescribing, preparing, and dispensing medicines, I beg to invite attention to the important and well-known fact that the difference between a minimum and a maximum dose of medicine frequently varies from one hundred to many hundred per cent., and that the dose of any medicinal agent is in no case fixed. It is not the "tablespoonful" and "teaspoonful" doses only that vary from 25 to 100 per cent. on account of the common difference in the size of the spoons, but the quantity by weight or measure to be given in a particular case is different according to the experience of the individual practitioner, which chiefly depends upon the strength and quality of the article he has been accustomed to administer. And again, what the most experienced physician believes, when he writes his prescription, will be the proper dose, may, very probably, be afterward

found too much or too little, and require correction. The dose of any medicine is usually supposed to be one grain, or a whole number of grains, or an even fraction of a grain; it is never $15\frac{1}{2}$ grains, or $14\frac{1}{2}$ grains, or 19 grains, or $\frac{1}{2}$ grain. It therefore depends to a certain extent upon the unit of weight itself. There can be, then, no strict rule as to doses. They are purely empirical. A difference of even one-tenth part, more or less, would be comparatively trifling in a dose of medicine, or in the strength of a preparation. Who could discover any difference in medicinal action between a fluid extract made of seventeen and six-tenths troy ounces to the pint and one made of sixteen troy ounces to the pint? Or who could discern a difference between the effect of one-half grain of morphine and the effect of eleven-twentieths grain of morphine? I believe that I am quite safe in asserting that the average prescription-scales used by dispensing pharmacists would not indicate a variation in weight between one-half and eleven-twentieths grain, and I leave it to the judgment of medical practitioners whether any difference in action would or could be appreciated.

One gram is equal to 15.43234874 troy grains.—(Professor Miller.) The difference between 15 and 15.43234874 is about one thirty-fifth part, or $0.02882\frac{1}{2}$. (The fifteenth part of a gram is $1.02882\frac{1}{2}$ troy grains.) Strike out the fraction as being practically insignificant in medicine and pharmacy, and we have—

$$\begin{aligned}1 \text{ gram} &= 15 \text{ grains troy}; \\2 \text{ grains} &= 30 \text{ grains troy}; \\4 \text{ grains} &= 1 \text{ drachm troy}; \\32 \text{ grains} &= 1 \text{ onnce troy}.\end{aligned}$$

I conclude, from what has been said above concerning doses, that the one thirty-fifth part, more or less, in each dose, may be safely ignored. Thus, in reference to medicine and pharmacy, the simple numerical ratio of 15 to 1 can be properly applied in converting units of the one system of weights into units of the other, and the plea of troublesome and difficult computations, as against change, becomes feeble.

One grain is for that purpose conveniently taken to be equivalent to $0.066(\frac{1}{15})$ gram, or 6.6 centigrams, which may be readily remembered, and any number of troy grains can be converted into the corresponding number of decigrams by subtracting one-third, the result thus arrived at being sufficiently accurate, and the conversion of troy grains into grams, decigrams, or centigrams, is then a simple mental process.

Upon a comparison of the apothecaries' measures with metric cubic measures, we find that one cubic centimeter is equal to $16.2311678\frac{1}{2}$ minimis. One minim, unfortunately, does not weigh one grain, but about five per cent. less. If the minim weighed one grain, there would be the same number of minimis in the cubic centimeter as there are grains in the gram. The difference, however, between 15 and $16.2311678\frac{1}{2}$ is about one-twelfth part, or $0.08208\frac{1}{2}$. The fifteenth part of one cubic centimeter is $1.08208\frac{1}{2}$ minimis. The fraction, even in this case, is practically insignificant in medicine and pharmacy, and may be ignored. We would then have—

$$\begin{aligned}1 \text{ cubic centimeter} &= 15 \text{ minimis}; \\2 \text{ cubic centimeters} &= 30 \text{ minimis}; \\4 \text{ cubic centimeters} &= 1 \text{ fluid drachm}; \\32 \text{ cubic centimeters} &= 1 \text{ fluid ounce};\end{aligned}$$

and the conversion of minimis into cubic centimeters becomes as simple a process as is the conversion of grains into grams.

There can be no doubt (taking for granted that the simplicity, harmoniousness, and prospective universality of the metric system are such as should induce us to make it our own as rapidly as possible) that the government can substantially aid in its popularization. I believe that its simplicity is quite unnecessarily obscured in the elaborate articles and schemes which have been published from time to time. Articles are met with in journals, &c., the major portion of which is devoted to an explanation of the many prefixes used in connection with the metric units. This is certainly wrong. We should endeavor to make the matter as simple as possible, and then do what we can to learn and teach. Why so constantly parade before the public the meaning and derivation of *hecto*, and *deka*, and *deci*, &c., when it is almost certain that we will never use more than one or two units of each kind of value in each branch of art or science or business pursuit? Of our eagle, dollar, dime, cent, and mill, the dollar and cent only are referred to in our daily transactions. As the eagle, dime, and mill are disowned in actual practice, so will probably the hectogram, dekagram, decigram and milligram be disowned in writing and dispensing medical prescriptions. Even the term centigram may never be used except in the pharmacopoeia and other books, so that the term gram only remains. Why then make the metric system appear difficult and complicated when in reality it ought to appear, because it is, as simple as our monetary system? As we do not keep books and compute accounts in eagles, dollars, dimes, cents, and mills, so we will not compute weight in kilograms, hectograms, dekagrams, grams, decigrams, centigrams, and milligrams, and it is, therefore, unimportant to keep all these at once or together in our minds. I regret that some really earnest friends of the metric system should have published a chart, of which a copy is to be

found in nearly every college or school, and in which chart we find in addition to the prefixes *myria*, *kilo*, *hecto*, *deka*, *deci*, *centi*, and *milli*, also two other prefixes used in connection with those just named and with the standard units, *demi* and *double*, thus creating 24 different units of each kind of value. The enumeration only of these many units as applied to weights would be sufficiently discouraging to seriously impair the prospect of their ultimate popularization. The array is as follows:

1. Demi-milligram.
2. Milligram.
3. Double-milligram.
4. Demi-centigram.
5. Centigram.
6. Double-centigram.
7. Demi-decigram.
8. Decigram.
9. Double-decigram.
10. Demigram.
11. Gram.
12. Double-gram.
13. Demi-dekagram.
14. Dekagram.
15. Double-dekagram.
16. Demi-hectogram.
17. Hectogram.
18. Double-hectogram.
19. Demi-kilogram.
20. Kilogram.
21. Double-kilogram.
22. Demi-myriagram.
23. Myriagram.
24. Double-myriagram.

Corresponding units are given for the various kinds of measures respectively. It is not under such circumstances surprising that young and old shrink from the effort to master the metric system.

It is also easier to speak plain English than to inject a number of artificial terms derived from the dead languages, and there is nothing gained by the latter. It is, to me at least, more convenient to say "ten grams" than to say "one dekagram," and I think all who have actually used metric weights in medicine and pharmacy will agree that for these purposes the decigram as a unit is quite superfluous. The expressions "double-dekagram," "demi-kilogram," &c., I refrain from commenting upon. It will not do to say that the terms "hectogram," "decigram," &c., are not *units*, but simply another way of expressing multiples or fractional parts of the standard unit, for, practically, they are units; and multiples and fractional parts of the gram are most conveniently and familiarly expressed in common English terms.

I can see no objection to abbreviating the term centigram into *cent*. in every-day parlance, and even in writing. The use of the word "cent" in reference to money surely would not interfere with its use in weights and measures also, for the text, or the connection in which it is used, would not fail to fix its meaning. The word "pound" is in England applied to money as well as weight, without the slightest inconvenience or ambiguity. The simplest system possible would be one modeled upon our monetary system, the metric standard units being adopted, with their subdivisions into one hundred parts. We would thus have, for instance:

1 meter (about $3\frac{1}{2}$ inches longer than the yard) divided into 100 cents (centimeters).
1 liter (about 2 fluid ounces more than the quart) divided into 100 cents (centiliters).

1 gram (equal to about 15 grains or $\frac{1}{2}$ apothecaries' drachm) divided into 100 cents (centigrams).

The cubic measure would of course not come under this rule; but the cubic centimeter might well be popularly abbreviated into *cube cent*. This arrangement would not be sufficient for universal use, but it would not interfere with the use of kilos, hectos, dekas, dimes, and mills by those whose purposes these subdivisions would best subserve. Probably, as I have already said, no one art or science or business pursuit requires more than one or two units of each kind of value, and each will choose the one or two best adapted to its own use. This fact ought to be permitted to facilitate the introduction of the metric system. Chemists will use grams and mills (milligrams); pharmacists will use grams and cents (centigrams); grocers might use kilos (kilograms) and dekas (dekagrams), &c. The fact that the metric system offers so many units from which we may select those best suited to our wants for special uses is admirable, but while all of these units may be actually utilized, they will not all be applied together in any one art, science, or business pursuit.

Until we shall have become quite familiar with the metric units there can be no doubt that rules for conversion and tables of approximate equivalents will be not only useful but absolutely necessary. Their utility, however, will end as soon as we shall have mastered them perfectly, which requires but little time and effort. As soon as we can think in metric terms, then the rules of conversion, the tables of equivalents, and everything pertaining to the old system of weights and measures may profitably be dropped and forgotten.

We would do well to begin by making rough comparisons between the old units and the new, as have been done above. Then let us obtain as many different OBJECT-LESSONS as possible, and examine, handle, and use them until they have become perfectly familiar. Metric weights, graduated measures, vials, and a centimeter rule would be the most useful. Our metric coins, also, may be made to serve a good purpose in this

connection. Our five-cent nickels weigh one gram for every cent they represent; our half-dollar and quarter-dollar pieces weigh twenty-five grams for every dollar, or twenty-five centigrams for every cent, consequently one dollar in five-cent nickels weighs 100 grams; two dollars in silver half-dollars or quarters weighs 50 grams, and one dollar, 25 grams. Two five-cent nickels make up ten grams, one of them serving for a five-gram weight; and one silver dime piece weighs $2\frac{1}{2}$ grams. These coins make good and quite reliable metric medicinal weights as far as they go. If the weight of each coin were stamped upon it in metric terms, it would be of immense advantage in popularizing the metric system of weights.

Rules for converting apothecaries' weights and measures into their respective equivalents in metric terms for medical and pharmaceutical purposes, and suggestions for writing metric prescriptions, and for preparing requisitions for medical supplies in metric terms; together with a metric posological table.

The following very simple rules for the conversion of quantities expressed in the terms of the old system into their equivalents expressed in terms of the new system, and vice versa, will be found valuable, and are easily applied. With the aid of these rules, there will be no difficulty in writing or dispensing prescriptions, or in making preparations, employing metric terms and quantities, even without any previous knowledge of the latter. I believe that the application of these rules for a brief time will result in a sufficient familiarity with the metric system to render their further use superfluous. A moderate acquaintance with metric quantities, by linear measure, by weight, and by volume, is soon acquired, such as will obviate a necessity for thinking in inches or grains or minims and then translating these units into the corresponding number of meters, grams, or cubic centimeters:

RULES.

1. TO EXPRESS QUANTITIES BY WEIGHT OF THE APOTHECARIES' SYSTEM IN METRIC TERMS, OR TO WRITE MEDICAL PRESCRIPTIONS IN METRIC WEIGHTS.

RULE A.—Reduce each quantity to troy grains; then divide the number by 10 (or move the decimal point one place to the left); and from the quotient subtract one-third. The remainder is in each case the number of grams representing (nearly) the same quantity. Or,

RULE B.—Reduce each quantity to apothecaries' drachms and multiply the number by 4. The product is in each case the number of grams representing (nearly) the same quantity. Or,

RULE C.—Reduce each quantity to troy ounces, and multiply the number by 32. The product is in each case the number of grams representing (nearly) the same quantity.

"One gram is equal to 15.43234574 troy grains.—(Professor Miller.) In preparing the above rules the fraction has been ignored, as for medical and pharmaceutical purposes 1 gram and 15 troy grains may be safely considered as equal quantities. In Rule A, therefore, a division by 15 may, if preferred, be substituted for the division by 10 followed by a subtraction of one-third from the quotient, with the same result. The difference between 15 and 15.43234574 is 2.82 + per cent., and hence the deviation from exactness in the answer arrived at by either of the above rules corresponds to an excess of 2.82 + grains for every 1,000 grains. To illustrate: By Rule B, 4,000 grains would be (nearly) equivalent to 1,000 drachms; but 4,000 cubic centimeters is equal to exactly 61,729.40 + troy grains, while 1,000 drachms is only 60,000 troy grains. The deviation from exactness, therefore, in the answer arrived at by Rule B (as also in the answers arrived at by Rules A and C) is equivalent to an excess of 1,729.40 + troy grains for every 1,000 drachms, or about 14 grains for every ounce, or 28.82 + grains for every 1,000 grains, or less than 2.9 per cent.

"To insure greater accuracy, if in any case deemed necessary, three per cent. may be deducted from the answer arrived at by either of the Rules A, B, or C. The deviation from exactness will then be reduced to one-fifth of one per cent., the remainder being less than the exact equivalent sought by only 2.04 grains for every 1,000 grains, or about one grain for every ounce."

TO CONVERT TROY GRAINS INTO DECIGRAMS it is only necessary to deduct one-third; and

TO CONVERT TROY GRAINS INTO CENTIGRAMS multiply the number by 10 and from the product subtract one-third—the deviation from exactness in the answers arrived at in both cases being the same as in Rules A, B, and C, given above.

2. TO EXPRESS QUANTITIES BY MEASURE OF THE APOTHECARIES' SYSTEM IN METRIC TERMS, OR TO WRITE MEDICAL PRESCRIPTIONS IN METRIC CUBIC MEASURES.

RULE D.—Reduce each quantity to minims; then divide the number by 10 (or move the decimal point one place to the left), and from the quotient subtract one-third. The remainder is in each case the number of cubic centimeters representing (nearly) the same quantity. Or,

RULE E.—Reduce each quantity to fluid drachms, and multiply the number by 4. The product is in each case the number of cubic centimeters representing (nearly) the same quantity. Or,

RULE F.—Reduce each quantity to fluid ounces, and multiply the number by 32. The product is in each case the number of cubic centimeters* representing (nearly) the same quantity.

"One meter is equal to 39.370432 inches.—(Captain Clark.) Hence one cubic centimeter is equal to 0.0610253563 cubic inches, to 16.2311678 + minims (there being 61,440 minims in each wine-gallon of 231 cubic inches.) In preparing the above rules 1 cubic centimeter and 15 minims have been considered as equal quantities, which, for medical and pharmaceutical purposes, is sufficiently accurate. In Rule D, therefore, a division by 15 may, if preferred, be substituted for the division by 10 followed by a subtraction of one-third from the quotient, with the same result. The difference between 15 and 16.2311678 + is 8.203—per cent., and hence the deviation from exactness in the answer arrived at by either of the above rules corresponds to an excess of 82.03—minims for every 1,000 minims. To illustrate: By Rule E, 4,000 cubic centimeters would be (nearly) equivalent to 1,000 fluid drachms; but 4,000 cubic centimeters is equal to exactly 64,924.67 + minims, while 1,000 fluid drachms is only 60,000 minims. The deviation from exactness, therefore, in the answer arrived at by Rule E (as also in the answers arrived at by Rules D and F), is equivalent to an excess of 4,924.67 + minims for every 1,000 fluid drachms, or about 41 minims for every fluid ounce, or 82.03—minims for every 1,000 minims, or 8.2 per cent.

"To insure greater accuracy, if in any case deemed necessary, 8 per cent. may be deducted from the answer arrived at by either of the Rules D, E, or F. The deviation from exactness will then be reduced to less than one-half of 1 per cent., the remainder being less than the exact equivalent sought by only 4.49—minims for every 1,000 minims, or less than $2\frac{1}{4}$ minims for every fluid ounce."

The important advantage of a simple relation between the units of weight and the units of measure is acknowledged, and is one of the strong arguments in favor of the metric system, the weight unit or "gram" being the weight of one cubic centimeter of distilled water of maximum density under the pressure of one atmosphere. The minim and the grain, however, have no simple relation to each other; but as the difference between the weight of one minim of distilled water of maximum density under the pressure of one atmosphere, and the weight of a troy grain, is comparatively small, it has been ignored entirely in preparing the rules for the conversion of apothecaries' measure into metric measure (Rules D, E, and F), and hence the arithmetical processes in the rules for converting old measures into new are respectively identical with the processes given in the rules for converting weights, as will be seen upon comparison of Rule D with Rule A, Rule E with Rule B, and Rule F with Rule C. For this purpose one minim is considered as weighing one troy grain, one fluid drachm as weighing one apothecaries' drachm, and one fluid ounce as weighing one troy ounce. (See below the "table of approximate equivalents of apothecaries' weights and measures in metric terms, as obtained in accordance with the rules herein given.")

Practically one cubic centimeter and one gram may be considered as equal quantities, except with very heavy or very light liquids.

It will be seen that if the three rules A, B, and C be all applied in converting the several quantities by weight in any one prescription or formula, the original proportions between these quantities will still be preserved, the deviation from exactness being invariable. It will also be seen that the three rules D, E, and F may be all applied in converting the several quantities by measure in any one prescription or formula without disturbing the original proportions between said quantities. Thus, if all the ingredients in the formula be expressed by weight, or if they all be expressed by measure, the rules given may be employed indiscriminately without changing the character of the formula in the least. But if in any one formula both weights and measures are used together, then the proportions between the quantities by weight and the quantities by measure will be changed, so that in the metric formula, constructed according to the rules given, the measured quantities will be about five per cent. larger in proportion to the weighed quantities, the deviation from exactness in the measures being an excess of eight per cent., while in the weights it is an excess of only three per cent. Thus, if a prescription for one grain of strychnia salt dissolved in four fluid ounces of water be converted into metric terms by the application of these rules, the metric

*See foot-note, page 95.

formula arrived at would give us a solution *five per cent. weaker*, which is an absolutely insignificant difference.

Should, at the same time, the dose of the preparation be indicated in cubic centimeters according to the rules given, instead of in fluid drachms, then, as the dose is increased eight per cent., while the strength of the medicine is diminished five per cent., even that insignificant difference would be lessened.

Rules A and E are the most generally applicable and convenient in constructing prescriptions.

In applying the foregoing rules for writing prescriptions, the metric quantities should be adjusted so as to be expressed in as simple decimal terms as may be practicable, without materially changing the dose or the character of the formula.

The terms "gram" and "cubic centimeter" might be abbreviated "Gm." and "C. C." To preclude the possibility (in *careless writing*), however of mistaking the sign Gm. (gram) for the sign "gr." (grain), the number should invariably precede the sign, using the common Arabic numerals. Thus, while ten grains is always written "gr. x" (Roman numerals being used), ten grams would be written "10 Gm." When the term "centigram" is used it should be spelled out in full. Ten centigrams might, however, more conveniently be written "0.10 Gm." than "10 centigrams." In writing, the abbreviated metric denominations should always be underscored, but the preceding number should not, as above.

Two examples will suffice to illustrate the foregoing rules and suggestions. The following prescription:

R: Extr. Coloc. Comp., 3iss.
Extr. Colch. Acet., gr. xii.
Extr. Digitalis, gr. vj.

Make into 24 pills—

would, in metric terms, be written:

R: Extr. Coloc. Comp., 6 Gm. (See Rule B.)
Extr. Colch. Acet., 0.8 Gm. (See Rule A.)
Extr. Digitalis, 0.4 Gm. (See Rule A.)

Make into 24 pills.

Or, in a more finished decimal manner—

R: Extr. Coloc. Comp., 7.50 Gm.
Extr. Colch. Acet., 1 Gm.
Extr. Digitalis, 0.50 Gm.
Make into 24 pills.

And the following prescription:

R: Potassii Bromidi, 2*i.*
Elix. Aurantii, fl. $\frac{2}{3}$ viij.
Mix—

would, in metric terms, be written:

R: Potassii Bromidi, 32 Gm. (See Rule C.)
Elix. Aurantii, 256 C. C. (See Rule F.)
Mix.

Or, in a more finished decimal manner,

R: Potassii Bromidi, 30 Gm.
Elix. Aurantii, 250 C. C.
Mix.

The use of a decimal line instead of the *decimal points* as suggested by Dr. Bolles, of Boston, would prevent possible errors. A metric prescription would then look as follows:

R: Hydrarg. Chloridi. Corros. 0.25 Gm.
Potassii Iodidi 10.00 Gm.
Aquaæ 100.00 C. C.
Tinct. Chinch. Comp. 100.00 C. C.
Mix.

The exact equivalents of the grain, drachm, and ounce (troy), in grams; of the gram in grains; of the minim, fluidrachm, and fluidounce in cubic centimeters, and of the cubic centimeter in minims, are as follows:

1 grain (troy) is equal to 0.065—gram.

1 drachm (troy) is equal to 3.888—grams.

1 ounce (troy) is equal to 31.103+ grams.
1 gram is equal to 15.43234874 grains (troy).—*Professor Miller.*
1 minim is equal to 0.062—cubic centimeter.
1 fluidrachm is equal to 3.697—cubic centimeters.
1 fluidounce is equal to 29.573—cubic centimeters.
1 cubic centimeter is equal to 16.231+ minims.
(1 meter is equal to 39.370432 inches.—*Captain Clarke.*)
(1 avoirdupois pound is equal to 453.592+ grams.)
(1 avoirdupois ounce is equal to 28.350+ grams.)

Table of approximate equivalents of apothecaries' weights and measures in metric terms, as obtained in accordance with the rules herein given.

	Gm.	C. C.
$\frac{1}{4}$ troy grain is nearly equal to.	0.0010	0.0010
$\frac{1}{3}$ do.....do.....	0.0013	0.0013
$\frac{1}{4}$ do.....do.....	0.0016	0.0016
$\frac{1}{5}$ do.....do.....	0.0020	0.0020
$\frac{1}{6}$ do.....do.....	0.0025	0.0025
$\frac{1}{7}$ do.....do.....	0.0033	0.0033
$\frac{1}{8}$ do.....do.....	0.0040	0.0040
$\frac{1}{9}$ do.....do.....	0.0050	0.0050
$\frac{1}{10}$ do.....do.....	0.0066	0.0066
$\frac{1}{11}$ do.....do.....	0.0080	0.0080
$\frac{1}{12}$ do.....do.....	0.0110	0.0110
$\frac{1}{13}$ do.....do.....	0.0133	0.0133
$\frac{1}{14}$ do.....do.....	0.016	0.016
$\frac{1}{15}$ do.....do.....	0.022	0.022
$\frac{1}{16}$ do.....do.....	0.033	0.033
$\frac{1}{17}$ do.....do.....	0.050	0.050
$\frac{1}{18}$ do.....do.....	0.066	0.066
$\frac{1}{19}$ troy grains is nearly equal to.	0.100	1/2 minim is nearly equal to...
$\frac{2}{19}$ do.....do.....	0.133	2 do.....do.....
$\frac{3}{19}$ do.....do.....	0.166	2½ do.....do.....
$\frac{4}{19}$ do.....do.....	0.200	3 do.....do.....
$\frac{5}{19}$ do.....do.....	0.266	4 do.....do.....
$\frac{6}{19}$ do.....do.....	0.400	6 do.....do.....
$\frac{7}{19}$ do.....do.....	0.466	7 do.....do.....
$\frac{8}{19}$ do.....do.....	0.533	8 do.....do.....
$\frac{9}{19}$ do.....do.....	0.600	9 do.....do.....
$\frac{10}{19}$ do.....do.....	0.666	10 do.....do.....
$\frac{11}{19}$ do.....do.....	0.733	11 do.....do.....
$\frac{12}{19}$ do.....do.....	0.800	12 do.....do.....
$\frac{13}{19}$ do.....do.....	0.866	13 do.....do.....
$\frac{14}{19}$ do.....do.....	0.933	14 do.....do.....
$\frac{15}{19}$ do.....do.....	1.000	15 do.....do.....
$\frac{16}{19}$ do.....do.....	1.066	16 do.....do.....
$\frac{17}{19}$ do.....do.....	1.200	18 do.....do.....
$\frac{20}{19}$ do.....do.....	1.333	20 do.....do.....
$\frac{22}{19}$ do.....do.....	1.466	22 do.....do.....
$\frac{24}{19}$ do.....do.....	1.600	24 do.....do.....
$\frac{26}{19}$ do.....do.....	1.733	26 do.....do.....
$\frac{28}{19}$ do.....do.....	1.866	28 do.....do.....
$\frac{30}{19}$ do.....do.....	2.000	30 do.....do.....
$\frac{32}{19}$ do.....do.....	2.133	32 do.....do.....
$\frac{33}{19}$ do.....do.....	2.222	33 do.....do.....
$\frac{34}{19}$ do.....do.....	2.288	34 do.....do.....
$\frac{36}{19}$ do.....do.....	2.400	36 do.....do.....
$\frac{38}{19}$ do.....do.....	2.533	38 do.....do.....
$\frac{39}{19}$ do.....do.....	2.600	39 do.....do.....
$\frac{40}{19}$ do.....do.....	2.666	40 do.....do.....
$\frac{42}{19}$ do.....do.....	2.800	42 do.....do.....
$\frac{44}{19}$ do.....do.....	2.933	44 do.....do.....
$\frac{45}{19}$ do.....do.....	3.000	45 do.....do.....
$\frac{46}{19}$ do.....do.....	3.066	46 do.....do.....
$\frac{48}{19}$ do.....do.....	3.200	48 do.....do.....
$\frac{50}{19}$ do.....do.....	3.333	50 do.....do.....
$\frac{56}{19}$ do.....do.....	3.800	56 do.....do.....

Table of approximate equivalents, &c.—Continued.

	G.m.		C.C.
1 apoth. drachm nearly equal.	4.00	1 fluid drachm nearly equal...	4.00
1½ apoth. drachms...do...	5.00	1½ fluid drachms...do...	5.00
1½ ...do...do...	6.00	1½ ...do...do...	6.00
1½ ...do...do...	7.00	1½ ...do...do...	7.00
2 ...do...do...	8.00	2 ...do...do...	8.00
2½ ...do...do...	10.00	2½ ...do...do...	10.00
3 ...do...do...	12.00	3 ...do...do...	12.00
4 ...do...do...	16.00	4 ...do...do...	16.00
5 ...do...do...	20.00	5 ...do...do...	20.00
6 ...do...do...	24.00	6 ...do...do...	24.00
7 ...do...do...	28.00	7 ...do...do...	28.00
1 troy ounce nearly equal...	32.00	1 fluidounce nearly equal...	32.00
1½ troy ounces...do...	48.00	1½ fluid ounces...do...	48.00
2 ...do...do...	64.00	2 ...do...do...	64.00
3 ...do...do...	96.00	3 ...do...do...	96.00
4 ...do...do...	128.00	4 ...do...do...	128.00
5 ...do...do...	160.00	5 ...do...do...	160.00
6 ...do...do...	192.00	6 ...do...do...	192.00
7 ...do...do...	224.00	7 ...do...do...	224.00
8 ...do...do...	256.00	8 ...do...do...	256.00
9 ...do...do...	288.00	9 ...do...do...	288.00
10 ...do...do...	320.00	10 ...do...do...	320.00
11 ...do...do...	352.00	11 ...do...do...	352.00
12 ...do...do...	384.00	12 ...do...do...	384.00
		13 ...do...do...	416.00
		14 ...do...do...	448.00
		15 ...do...do...	480.00
		16 ...do...do...	512.00

All that is necessary to know or learn of the metric system in order to write metric medical prescriptions, without a metric posological table, or with one, is:

IT IS SUFFICIENTLY ACCURATE AND SAFE TO CONSIDER 1 GRAM AS EXACTLY EQUAL TO 15 TROY GRAINS, AND TO CONSIDER 1 CUBIC CENTIMETER AS EQUAL TO 15 MINIMS.

We accordingly have:

1 gram equal to 15 troy grains ($\frac{1}{15}$).

1 troy grain equal to 0.066 gram ($\frac{1}{15}$).

1 cubic centimeter equal to $\frac{1}{15}$ fluiddrachm.

1 fluiddrachm equal to $\frac{1}{15}$ cubic centimeters.

In writing prescriptions the "gram" and "cubic centimeter" only should be used (abbreviated "Gm." and "C.C.").

The *centigram* should be used only in books and in speaking.

All other terms, and units and prefixes, used in the metric system may be wholly ignored in medicine and pharmacy.

These prefixes are simply numerals, as follows:

Myria, which means...	10,000
Kilo ...do...do...	1,000
Hecto...do...do...	100
Deka...do...do...	10
Deci...do...do...	0.1
Centi...do...do...	0.01
Milli...do...do...	0.001

and nearly all are quite unnecessary, English numerals being more convenient and at least equally explicit.

Weights may be exclusively employed, if preferred, all quantities being then, in prescriptions, expressed in GRAMS.

RULES FOR CONVERTING TERMS OF METRIC WEIGHTS AND MEASURES INTO THEIR RESPECTIVE EQUIVALENTS IN TERMS OF THE APOTHECARIES' SYSTEM OF WEIGHTS AND MEASURES.

1. TO CONVERT METRIC WEIGHT INTO APOTHECARIES' WEIGHT.

RULE G.—TO CONVERT ANY NUMBER OF GRAMS INTO THE CORRESPONDING NUMBER OF TROY GRAINS: *Add 50 per cent., and then multiply the sum by 10.* The product is in each case the number of troy grains representing (nearly) the same quantity. Or,

RULE H.—TO CONVERT ANY NUMBER OF GRAMS INTO THE CORRESPONDING NUMBER OF APOTHECARIES' DRACHMS: *Divide the number by 4.* The quotient is in each case the number of drachms representing (nearly) the same quantity. Or,

RULE I.—TO CONVERT ANY NUMBER OF GRAMS INTO THE CORRESPONDING NUMBER OF TROY OUNCES: *Divide by 32.* The quotient is in each case the number of troy ounces representing (nearly) the same quantity.

As already stated under Rules A, B, and C, one gram is equal to 15.43234874 troy grains, the fraction being ignored in the construction of these rules. This applies equally in Rules G, H, and I. In Rule G, therefore, a multiplication by 15 may, if preferable, be substituted for the addition of 50 per cent. followed by a multiplication of the sum by 10, with the same result. The answers arrived at by Rules G, H, and I, however, will be *too small* in about the same proportion as the answers arrived at by Rules A, B, and C were *too large*—less than 3 per cent. To illustrate: By Rule G, 15,000 troy grains would be (nearly) equivalent to 1,000 grams; but 1,000 grams is equal to exactly 15,432.34874 troy grains. The deviation from exactness, therefore, in the answer arrived at by Rule G (as also in the answers arrived at by Rules H and I) is equivalent to a deficiency of 432.35 troy grains for every 1,000 grams, or about 28 grains for every 1,000 grains, or less than 3 per cent.

"To insure greater accuracy, if in any case deemed necessary, 3 per cent. may be added to the answer arrived at by either of the Rules G, H, and I. The deviation from exactness will then be reduced to one-eighth of one per cent., the sum being in excess of the exact equivalent sought by only 18 troy grains, or 1.166 grams for every 1,000 grams, or only about three-fifths grain for every troy ounce."

To CONVERT DECIGRAMS INTO TROY GRAINS it is only necessary to *add 50 per cent.*; and

To CONVERT CENTIGRAMS INTO TROY GRAINS *add 50 per cent., and then divide by 10*—the deviation from exactness in the answers arrived at in both cases being the same as in Rules G, H, and I, given above.

2. TO CONVERT METRIC CUBIC MEASURE INTO APOTHECARIES' MEASURE.

RULE K.—TO CONVERT ANY NUMBER OF CUBIC CENTIMETERS INTO THE CORRESPONDING NUMBER OF MINIMS: *Add 50 per cent., and then multiply the sum by 10.* The product is in each case the number of minims representing (nearly) the same quantity. Or,

RULE L.—TO CONVERT ANY NUMBER OF CUBIC CENTIMETERS INTO THE CORRESPONDING NUMBER OF FLUIDDRACHMS: *Divide the number by 4.* The quotient is in each case the number of fluiddrachms representing (nearly) the same quantity. Or,

RULE M.—TO CONVERT ANY NUMBER OF CUBIC CENTIMETERS INTO THE CORRESPONDING NUMBER OF FLUIDOUNCE: *Divide by 32.* The quotient is in each case the number of fluidounces representing (nearly) the same quantity.

The deviation from exactness in the answers arrived at by Rules K, L, and M, is of course about the reverse of that in the answers arrived at by Rules D, E, and F. To illustrate: By Rule K, 15,000 minims would be (nearly) equivalent to 1,000 cubic centimeters; but 1,000 cubic centimeters is equal to exactly 16,231.1678+ minims. The deviation from exactness, therefore, in the answers arrived at by Rule K (as also in the answers arrived at by Rules L and M) is equivalent to a deficiency of 1,231.17 minims for every 1,000 cubic centimeters, or about 76 minims for every 1,000 minims, or less than 8 per cent.

"To insure greater accuracy, if in any case deemed necessary, 8 per cent. may be added to the answer arrived at by either of the Rules K, L, and M. The deviation from exactness will then be reduced to less than one-twelfth of 1 per cent., the sum being in excess of the exact equivalent sought by only 31 minims, or 0.8 cubic centimeter, for every 1,000 cubic centimeters, or only about one-third minim for every fluidounce."

RULES (FOR CONVERTING UNITED STATES WEIGHTS AND MEASURES INTO METRIC) APPLICABLE IN THE PREPARATION OF REQUISITIONS FOR AND INVOICES OF MEDICAL SUPPLIES.

RULE N.—TO CONVERT AVOIRDUPOIS POUNDS INTO GRAMS (a), OR PINTS INTO CUBIC CENTIMETERS (b): *Multiply by 500 and deduct 10 per cent.*

NOTE.—(a.) The answer for *weights* arrived at by this rule will be *too small* by 55,433 grains for every 1,000 avoirdupois pounds, or about eight-tenths of 1 per cent. If 1 per cent. be added to that answer, the sum will be *too great* by only 14,012 grains for every 1,000 avoirdupois pounds, or 14 grains for every pound. *Ex.:* To find the number of grains equivalent to 1,000 avoirdupois pounds, multiply by 500 and deduct 10 per cent.; the answer will be 450,000, which is 3,592 less than the exact number of grains equivalent to 1,000 avoirdupois pounds. Add to the answer (450,000) 1 per cent. (4,500), and the sum will be 454,500, which is only 908 more than the exact number of grains equivalent to 1,000 avoirdupois pounds (453,592).

(b) The answer for *measures* arrived at by this rule will be *too small* by nearly 49 pints for every 1,000 pints, or nearly 5 per cent. If 5 per cent. be added to that answer, the sum will be *too small* by only 23½ fluidounces for every 1,000 pints, or 11

minims for every pint. *Ex.*: To find the number of cubic centimeters equivalent to 1,000 pints, multiply by 500 and deduct 10 per cent.; the answer will be 450,000, which is less by 23,163.74 than the exact number of cubic centimeters equivalent to 1,000 pints. Add to the answer (450,000) 5 per cent. (22,500), and the sum will be 472,500, which is only 663.74 less than the exact number of cubic centimeters equivalent to 1,000 pints (473,163.74).

RULE O.—TO CONVERT GRAMS INTO AVOIRDPOIS POUNDS (a), OR CUBIC CENTIMETERS INTO PINTS (b): Add 10 per cent. and divide by 500.

NOTE.—(a.) The answer for weights arrived at by this rule will be too small by 32.35 grains in every 1,000 grams, or about one-fourth per cent. If one-fourth per cent. be added to that answer, the result will be too great by only 6.3 grains for every 1,000 grams, or about one one-hundred-and-fiftieth of a grain for every gram. *Ex.*: To find the number of avoirdupois pounds equivalent to 1,000 grams, add 10 per cent. and then divide the sum by 500; the answer will be 2.2, which is 0.0046 less than the exact number of avoirdupois pounds equivalent to 1,000 grams. Add to the answer (2.2) one-fourth per cent. (0.0055) and the sum will be 2.2055, which is only 0.0009 more than the exact number of avoirdupois pounds equivalent to 1,000 grams (2.20462+).

(b.) The answer for measures arrived at by this rule will be too great by 0.09 pints for every 1,000 cubic centimeters, or about 4 per cent. If 5 per cent. be deducted from that answer, the sum will be too small by one-third fluid ounce for every 1,000 cubic centimeters, or one-sixth of a minim for every cubic centimeter. *Ex.*: To find the number of pints equivalent to 1,000 cubic centimeters, add ten per cent. and divide the sum by 500; the answer will be 2.20, which is more by 0.09 than the exact number of pints equivalent to 1,000 cubic centimeters. Deduct from the answer (2.20) 5 per cent. (0.11) and the remainder will be 2.09, which is only 0.02 less than the exact number of pints equivalent to 1,000 cubic centimeters (2.11+).

RULE P.—TO CONVERT AVOIRDPOIS POUNDS INTO HALF-KILOGRAMS (a) OR PINTS INTO HALF-LITERS (b): Deduct 10 per cent.*

RULE Q.—TO CONVERT HALF-KILOGRAMS INTO AVOIRDPOIS POUNDS (a) OR HALF-LITERS INTO PINTS (b). Add 10 per cent.†

RULE R.—TO CONVERT AVOIRDPOIS OUNCES INTO GRAMS: Multiply by 30 and then deduct 5 per cent.

NOTE.—The answer arrived at by this rule will be too great by about 5.30 avoirdupois ounces for every 1,000 avoirdupois ounces (about one-half of 1 per cent.), or 2.4 grains for every ounce. *Ex.*: To find the number of grams equivalent to 1,000 avoirdupois ounces, multiply by 30, and from the product deduct 5 per cent.; the answer will be 23,500, which is 150.46 more than the exact number of grams equivalent to 1,000 avoirdupois ounces (23,349.54).

RULE S.—TO CONVERT GRAMS INTO AVOIRDPOIS OUNCES: Divide by 30 and add 5 per cent.

NOTE.—The answer arrived at by this rule will be too small by 0.273 ounces for every 1,000 grams, or less than 0.3 grain for each gram.

RULE T.—TO CONVERT YARDS INTO METERS: Deduct 10 per cent.

NOTE.—The answer arrived at by this rule will be too small by 15.75 yards for every 1,000 yards, or a little over 1 $\frac{1}{2}$ per cent. If 1 $\frac{1}{2}$ per cent. be added to that answer, the sum will be too small by only about 35 $\frac{1}{2}$ inches for every 1,000 yards, or one-thirtieth inch for every yard. *Ex.*: To find the number of meters equivalent to 1,000 yards, deduct 100; the remainder, 900, lacks 14.39 of being the exact number of meters equivalent to 1,000 yards. Add to the answer (900) 1 $\frac{1}{2}$ per cent. (13.50) and the sum will be 913.50, which is only 0.9 less than the exact number of meters equivalent to 1,000 yards (914.39+).

RULE U.—TO CONVERT METERS INTO YARDS: Add 10 per cent.

NOTE.—The answer arrived at by this rule will be too great by 19.13 feet for every 1,000 meters, or a little over one-half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 32 $\frac{1}{2}$ inches for every 1,000 meters, or about one-thirtieth inch for every meter. *Ex.*: To find the number of yards equivalent to 1,000 meters, add 10 per cent.; the answer will be 1,100 or 6.38 more

* The answers, for weights and measures, respectively, arrived at by this rule, are as nearly the exact equivalents as are the answers arrived at by Rule N (a) and (b), and require similar corrections to insure greater accuracy, if deemed necessary.

† The answers, for weights and measures, respectively, arrived at by this rule, are as nearly the exact equivalents as are the answers arrived at by Rule O (a) and (b), and require similar corrections to insure greater accuracy, if deemed necessary.

than the exact number of yards equivalent to 1,000 meters. Deduct from the answer (1,100) one-half per cent. (5.50) and the remainder will be 1,094.50, which is only about 0.88 more than the exact number of yards equivalent to 1,000 meters (1,093.62+).

RULE W.—TO CONVERT FEET INTO METERS: Multiply by 3 and divide by 10.

NOTE.—The answer arrived at by this rule will be too small by 13.75 feet for every 1,000 feet, or a little over 1 $\frac{1}{2}$ per cent. If 1 $\frac{1}{2}$ per cent. be added to that answer, the sum will be too small by only about one foot for every 1,000 feet, or about one-eightieth inch for every foot. *Ex.*: To find the number of meters equivalent to 1,000 feet, multiply by 3 and divide the product by 10; the answer will be 300, or 4.8 less than the exact number of meters equivalent to 1,000 feet. Add to the answer (300) 1 $\frac{1}{2}$ per cent. (4.50), and the sum will be 304.50, which is only about 0.3 less than the exact number of meters equivalent to 1,000 feet (304.80—).

RULE X.—TO CONVERT METERS INTO FEET: Add 10 per cent. and multiply by 3.

NOTE.—The answer arrived at by this rule will be too great by 19.13 feet for every 1,000 meters, or about one-half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 2 $\frac{1}{2}$ feet for every 1,000 meters, or one-thirtieth inch for every meter. *Ex.*: To find the number of feet equivalent to 1,000 meters, add 10 per cent. and multiply by 3; the answer will be 3,300.00, or 19.13 more than the exact number of feet equivalent to 1,000 meters. Deduct from the answer (3,300.00) one-half per cent. (16.50), and the remainder will be 3,283.50, which is only about 2 $\frac{1}{2}$ more than the exact number of feet equivalent to 1,000 meters (3,280.87—).

RULE Y.—TO CONVERT INCHES INTO METERS: Divide by 40.

NOTE.—The answer arrived at by this rule will be too small by 15.75 inches for every 1,000 inches, or about 1 $\frac{1}{2}$ per cent. If 1 $\frac{1}{2}$ per cent. be added to that answer, the sum will be too small by about 1 inch for every 1,000 inches, or about $\frac{1}{1000}$ inch for every inch. *Ex.*: To find the number of meters equivalent to 1,000 inches, divide by 40; the answer will be 25, which is 0.4 less than the exact number of meters equivalent to 1,000 inches. Add to the answer (25) 1 $\frac{1}{2}$ per cent. (.375), and the sum will be 25.375, which is only about 0.025 less than the exact number of meters equivalent to 1,000 inches (25.40—).

RULE Z.—TO CONVERT METERS INTO INCHES: Add 10 per cent. and multiply by 36.

NOTE.—The answer arrived at by this rule will be too great by 19.13 feet for every 1,000 meters, or about one-half per cent. If one-half per cent. be deducted from that answer, the remainder will be too great by only about 2 $\frac{1}{2}$ feet for every 1,000 meters, or one-thirtieth inch for every meter. *Ex.*: To find the number of inches equivalent to 1,000 meters, add 10 per cent. and multiply by 36; the answer will be 39,600, which is 229.57 more than the exact number of inches equivalent to 1,000 meters. Deduct from the answer (39,600) one-half per cent. (198), and the remainder will be 39,402, which is only 31.57 more than the exact number of inches equivalent to 1,000 meters (39,370.43).

In preparing requisitions for medical supplies, 500 grams might be estimated for instead of 1 avoirdupois pound, the latter being about 1 $\frac{1}{2}$ ounces less than the former quantity; 30 grams might be estimated for instead of one ounce (avoirdupois), the latter being about 20 grains less than the former quantity; and 5 grams might be estimated for instead of one-eighth ounce (avoirdupois), the latter being 20 grains less; 500 cubic centimeters might be estimated for instead of 16 fluid ounces, the latter being about 1 fluid ounce less; and 30 cubic centimeters might be estimated for instead of 1 fluid ounce, the latter being about 30 minimis less than the former quantity. One meter might be estimated for instead of 1 yard, the latter being about 3 $\frac{1}{2}$ inches less than the former.

I append tables showing the relation of the metric units of measurement of length, volume, and weight—the only units with which we have to do in surveying, and for medical and pharmaceutical purposes generally—to our present units, and vice versa, together with a posological table, in which the doses are stated in terms of both the apothecaries' and the metric system.

A.—RELATION OF METRIC TO ENGLISH MEASURES OF LENGTH.

(1 meter = 39.370432 inches.—Clarke.) *

Meters.	Equivalents in—			Meters.	Equivalents in—		
	Inches.	Feet.	Yards.		Inches.	Feet.	Yards.
0.001	0.039			11	433.075	36.099	12.030
0.010	0.394			12	472.445	39.370	13.123
0.100	3.937	0.328	0.109	13	511.816	42.651	14.217
1.000	39.370	3.281	1.094	14	551.186	45.932	15.311
2	78.741	6.562	2.187	15	590.556	49.213	16.404
3	118.111	9.843	3.281	16	629.927	52.494	17.498
4	157.482	13.123	4.374	17	669.297	55.775	18.592
5	196.852	16.404	5.468	18	708.668	59.056	19.685
6	236.223	19.685	6.562	19	748.038	62.337	20.779
7	275.593	22.966	7.655	20	787.409	65.617	21.872
8	314.963	26.247	8.749	100	3937.043	328.087	109.362
9	354.334	29.52	9.843	1,000	3,9370.432	3280.869	1,093.623
10	393.704	32.593	10.936				

B.—RELATION OF ENGLISH TO METRIC MEASURES OF LENGTH.

* [1 yard = 0.91439175 meters.]

Meters.		Meters.	
1 inch is equal to	0.025	17 feet is equal to	5.182
2 inches is equal to	0.051	18 do. do. do.	5.456
3 do. do.	0.076	19 do. do. do.	5.791
4 do. do.	0.102	20 do. do. do.	6.096
5 do. do.	0.127	21 do. do. do.	6.401
6 do. do.	0.152	22 do. do. do.	6.706
7 do. do.	0.178	23 do. do. do.	7.010
8 do. do.	0.203	24 do. do. do.	7.315
9 do. do.	0.229	25 do. do. do.	7.620
10 do. do.	0.254	26 do. do. do.	7.925
11 do. do.	0.279	27 do. do. do.	8.230
1 foot is equal to	0.305	28 do. do. do.	8.534
2 feet is equal to	0.610	29 do. do. do.	8.839
3 do. do.	0.914	30 do. do. do.	9.144
4 do. do.	1.219	31 do. do. do.	9.449
5 do. do.	1.524	32 do. do. do.	9.754
6 do. do.	1.829	33 do. do. do.	10.058
7 do. do.	2.134	34 do. do. do.	10.363
8 do. do.	2.438	35 do. do. do.	10.668
9 do. do.	2.743	36 do. do. do.	10.973
10 do. do.	3.048	37 do. do. do.	11.277
11 do. do.	3.353	38 do. do. do.	11.582
12 do. do.	3.658	39 do. do. do.	11.887
13 do. do.	3.962	40 do. do. do.	12.192
14 do. do.	4.267	50 do. do. do.	15.240
15 do. do.	4.572	100 do. do. do.	30.480
16 do. do.	4.877		

(1 square meter is equal to 1550.030915870 square inches.)

C.*—RELATION OF METRIC TO ENGLISH CUBIC MEASURES.

	Minims.	Fl. drs.	
0.05 cubic centimeter is equal to.	0.81 +	4 cubic centimeters is equal to.	1.08 +
0.06 do. do. do.	0.97 +	5 do. do. do.	1.35 +
0.07 do. do. do.	1.14 —	6 do. do. do.	1.62 +
0.08 do. do. do.	1.30 —	7 do. do. do.	1.89 +
0.09 do. do. do.	1.46 +	8 do. do. do.	2.16 +
0.10 do. do. do.	1.62 +	9 do. do. do.	2.43 +
0.11 do. do. do.	1.79 —	10 do. do. do.	2.71 —
0.12 do. do. do.	1.95 —	20 do. do. do.	5.41 +
0.13 do. do. do.	2.11 +		Fl. ozs.
0.14 do. do. do.	2.27 +	30 do. do. do.	1.01 +
0.15 do. do. do.	2.43 +	40 do. do. do.	1.35 +
0.16 do. do. do.	2.60 —	50 do. do. do.	1.69 +
0.17 do. do. do.	2.76 —	60 do. do. do.	2.03 —
0.18 do. do. do.	2.92 +	70 do. do. do.	2.37 —
0.19 do. do. do.	3.08 +	80 do. do. do.	2.71 —
0.20 do. do. do.	3.25 —	90 do. do. do.	3.04 +
0.25 do. do. do.	4.06 —	100 do. do. do.	3.38 +
0.30 do. do. do.	4.87 +	150 do. do. do.	5.07 +
0.35 do. do. do.	5.68 —	200 do. do. do.	6.76 +
0.40 do. do. do.	6.49 +	250 do. do. do.	8.45 +
0.45 do. do. do.	7.30 +	300 do. do. do.	10.14 +
0.50 do. do. do.	8.12 —	350 do. do. do.	11.84 —
0.55 do. do. do.	8.93 —	400 do. do. do.	13.53 —
0.60 do. do. do.	9.74 —	450 do. do. do.	15.22 —
0.65 do. do. do.	10.55 +		Pints.
0.70 do. do. do.	11.36 +	12.17 +	
0.75 do. do. do.	12.98 +	500 do. do. do.	1.06 —
0.80 do. do. do.	13.50 —	600 do. do. do.	1.27 —
0.85 do. do. do.	16.61 —	700 do. do. do.	1.45 —
0.90 do. do. do.	15.42 —	800 do. do. do.	1.69 +
0.95 do. do. do.	16.23 +	900 do. do. do.	1.90 +
1 do. do. do.	32.46 +	1,000 do. do. do.	2.11 —
2 do. do. do.	48.69 +		

* See foot-note to page 95.

D.—RELATION OF ENGLISH TO METRIC CUBIC MEASURES.

	C. C.		C. C.
1 minim is equal to.....	0.06+	5 fluid drams is equal to	18.48+
2 minimis is equal to.....	0.12+	6.....do.....do.....	22.18-
3.....do.....do.....	0.18+	7.....do.....do.....	25.88-
4.....do.....do.....	0.25-	8.....do.....do.....	29.57+
5.....do.....do.....	0.31-	9.....do.....do.....	33.27-
6.....do.....do.....	0.37-	10.....do.....do.....	36.97-
7.....do.....do.....	0.43+	11.....do.....do.....	40.66+
8.....do.....do.....	0.49+	12.....do.....do.....	44.36-
9.....do.....do.....	0.55+	13.....do.....do.....	48.06-
10.....do.....do.....	0.62-	14.....do.....do.....	51.75+
11.....do.....do.....	0.68-	15.....do.....do.....	55.45-
12.....do.....do.....	0.74-	16.....do.....do.....	59.10-
13.....do.....do.....	0.80+	3 fluid ounces is equal to	88.67-
14.....do.....do.....	0.86+	4.....do.....do.....	118.24+
15.....do.....do.....	0.92+	5.....do.....do.....	147.81+
16.....do.....do.....	0.99-	6.....do.....do.....	177.39-
17.....do.....do.....	1.05-	7.....do.....do.....	206.96-
18.....do.....do.....	1.11-	8.....do.....do.....	236.53+
19.....do.....do.....	1.17+	9.....do.....do.....	266.10+
20.....do.....do.....	1.23+	10.....do.....do.....	295.68-
21.....do.....do.....	1.29+	11.....do.....do.....	325.25+
22.....do.....do.....	1.36-	12.....do.....do.....	354.82+
23.....do.....do.....	1.42-	13.....do.....do.....	384.40-
24.....do.....do.....	1.48-	14.....do.....do.....	413.97-
25.....do.....do.....	1.54+	15.....do.....do.....	443.54+
26.....do.....do.....	1.60+	16.....do.....do.....	473.11+
27.....do.....do.....	1.66+	17.....do.....do.....	502.69-
28.....do.....do.....	1.73-	18.....do.....do.....	532.26-
29.....do.....do.....	1.79-	19.....do.....do.....	561.93+
30.....do.....do.....	1.85-	20.....do.....do.....	591.50-
35.....do.....do.....	2.16-	21.....do.....do.....	621.08-
40.....do.....do.....	2.46+	22.....do.....do.....	650.65-
45.....do.....do.....	2.77+	23.....do.....do.....	680.22-
50.....do.....do.....	3.08+	24.....do.....do.....	709.80+
55.....do.....do.....	3.39-	25.....do.....do.....	739.37-
60.....do.....do.....	3.70-	26.....do.....do.....	768.94+
70.....do.....do.....	4.31+	27.....do.....do.....	798.51+
80.....do.....do.....	4.93-	28.....do.....do.....	828.09-
90.....do.....do.....	5.54+	29.....do.....do.....	857.66-
100.....do.....do.....	6.16+	30.....do.....do.....	887.23-
110.....do.....do.....	6.78-	31.....do.....do.....	916.80+
120.....do.....do.....	7.39+	32.....do.....do.....	946.38-
3 fluid drachms is equal to	11.09-	64.....do.....do.....	1892.75+
4.....do.....do.....	14.79-	128.....do.....do.....	3785.51-

E.—RELATION OF METRIC TO APOTHECARIES' WEIGHTS.*

[1 gram = 15.2343874 troy grains.]

	Grains.		Grains.
0.0010 gram is equal to.....	0.015	0.0065 gram is equal to.....	0.100
0.0013.....do.....do.....	0.019	0.0070.....do.....do.....	0.108
0.0015.....do.....do.....	0.023	0.0075.....do.....do.....	0.116
0.0020.....do.....do.....	0.031	0.0080.....do.....do.....	0.123
0.0025.....do.....do.....	0.039	0.0085.....do.....do.....	0.131
0.0030.....do.....do.....	0.046	0.0090.....do.....do.....	0.139
0.0035.....do.....do.....	0.054	0.0095.....do.....do.....	0.147
0.0040.....do.....do.....	0.062	0.0100.....do.....do.....	0.154
0.0045.....do.....do.....	0.069	0.0125.....do.....do.....	0.193
0.0050.....do.....do.....	0.077	0.0150.....do.....do.....	0.231
0.0055.....do.....do.....	0.085	0.0200.....do.....do.....	0.309
0.0060.....do.....do.....	0.093	0.0250.....do.....do.....	0.386

* See foot-note to page 95.

E.—RELATION OF METRIC TO APOTHECARIES' WEIGHT—Continued.

	Grains.		Grains.
0.0300 gram is equal to.....	0.463	14 grams is equal to.....	216.053
0.0350.....do.....do.....	0.540	15.....do.....do.....	231.485
0.0400.....do.....do.....	0.617	16.....do.....do.....	246.918
0.0450.....do.....do.....	0.694	17.....do.....do.....	262.350
0.050.....do.....do.....	0.772	18.....do.....do.....	277.782
0.055.....do.....do.....	0.849	19.....do.....do.....	293.215
0.060.....do.....do.....	0.926	20.....do.....do.....	308.647
0.065.....do.....do.....	1.003	21.....do.....do.....	324.079
0.070.....do.....do.....	1.080	22.....do.....do.....	339.512
0.075.....do.....do.....	1.157	23.....do.....do.....	354.944
0.080.....do.....do.....	1.235	24.....do.....do.....	370.376
0.085.....do.....do.....	1.312	25.....do.....do.....	385.809
0.090.....do.....do.....	1.389	26.....do.....do.....	401.241
0.095.....do.....do.....	1.466	27.....do.....do.....	416.673
0.100.....do.....do.....	1.543	28.....do.....do.....	432.106
0.110.....do.....do.....	1.698	29.....do.....do.....	447.538
0.120.....do.....do.....	1.852	30.....do.....do.....	462.970
0.130.....do.....do.....	0.006	31.....do.....do.....	478.403
0.140.....do.....do.....	2.161	32.....do.....do.....	493.835
0.150.....do.....do.....	2.315	33.....do.....do.....	509.268
0.160.....do.....do.....	2.469	34.....do.....do.....	524.700
0.170.....do.....do.....	2.623	35.....do.....do.....	540.132
0.180.....do.....do.....	2.778	36.....do.....do.....	555.565
0.190.....do.....do.....	2.932	37.....do.....do.....	579.907
0.200.....do.....do.....	3.086	38.....do.....do.....	586.429
0.210.....do.....do.....	3.241	39.....do.....do.....	601.862
0.220.....do.....do.....	3.395	40.....do.....do.....	617.294
0.230.....do.....do.....	3.549	50.....do.....do.....	771.617
0.240.....do.....do.....	3.704	60.....do.....do.....	925.941
0.250.....do.....do.....	3.858	70.....do.....do.....	1,080.264
0.260.....do.....do.....	4.012	80.....do.....do.....	1,234.588
0.270.....do.....do.....	4.167	90.....do.....do.....	1,388.911
0.280.....do.....do.....	4.321	100.....do.....do.....	1,543.235
0.290.....do.....do.....	4.475	125.....do.....do.....	1,929.044
0.300.....do.....do.....	4.630	150.....do.....do.....	2,314.852
0.310.....do.....do.....	4.784	200.....do.....do.....	3,086.470
0.320.....do.....do.....	4.938	250.....do.....do.....	3,858.087
0.330.....do.....do.....	5.093	300.....do.....do.....	4,629.705
0.340.....do.....do.....	5.247	333.....do.....do.....	5,144.118
0.350.....do.....do.....	5.401	350.....do.....do.....	5,401.322
0.360.....do.....do.....	5.556	400.....do.....do.....	6,172.940
0.370.....do.....do.....	5.710	450.....do.....do.....	6,944.557
0.380.....do.....do.....	5.864	500.....do.....do.....	7,716.174
0.390.....do.....do.....	6.019	600.....do.....do.....	9,259.409
0.400.....do.....do.....	6.175	700.....do.....do.....	10,802.644
0.500.....do.....do.....	7.716	750.....do.....do.....	11,574.262
0.600.....do.....do.....	9.259	800.....do.....do.....	12,345.579
0.700.....do.....do.....	10.803	900.....do.....do.....	13,880.114
0.800.....do.....do.....	12.346	1,000.....do.....do.....	15,432.35
0.900.....do.....do.....	13.889	1,500.....no.....do.....	23,148.52
1.....do.....do.....	15.432	2,000.....no.....do.....	30,864.70
2.....do.....do.....	30.863	2,500.....no.....do.....	38,580.87
3.....do.....do.....	46.297	3,000.....no.....do.....	46,297.05
4.....do.....do.....	61.729	3,500.....no.....do.....	54,013.22
5.....do.....do.....	77.162	4,000.....no.....do.....	61,729.40
6.....do.....do.....	92.594	4,500.....no.....do.....	68,445.57
7.....do.....do.....	108.026	5,000.....no.....do.....	77,161.74
8.....do.....do.....	123.459	10,000.....no.....do.....	154,432.35
9.....do.....do.....	138.891	20,000.....no.....do.....	308,646.97
10.....do.....do.....	154.323	25,000.....no.....do.....	385,808.72
11.....do.....do.....	169.756	50,000.....no.....do.....	771,617.44
12.....do.....do.....	185.188	100,000.....no.....do.....	1543,234.87
13.....do.....do.....	200.620		

F.—RELATION OF APOTHECARIES' TO METRIC WEIGHTS.

[1 troy grain = 0.06479895 + gram.]

	Gm.		Gm.
1 troy grain is equal to	0.00101 +	25 troy grains are equal to...	1.620 +
do. do.	0.00108 -	26 do. do.	1.685 -
do. do.	0.00130 -	27 do. do.	1.749 +
do. do.	0.00135 -	28 do. do.	1.814 -
do. do.	0.00162 -	29 do. do.	1.869 -
do. do.	0.00180 -	30 do. do.	1.944 -
do. do.	0.00202 +	40 do. do.	2.592 -
do. do.	0.00216 -	50 do. do.	3.240 -
do. do.	0.00259 +	1 drachm is equal to	3.880 -
do. do.	0.00270 -	2 drachms are equal to	7.776 -
do. do.	0.00324 -	3 do. do.	11.664 -
do. do.	0.00360 -	4 do. do.	15.552 -
do. do.	0.00405 -	5 do. do.	19.440 -
do. do.	0.00432 -	6 do. do.	23.328 -
do. do.	0.00540 -	7 do. do.	27.216 -
do. do.	0.00648 -	1 ounce is equal to	31.103 +
do. do.	0.00810 -	1½ ounces are equal to	46.655 +
do. do.	0.01080 -	2 do. do.	62.207 -
do. do.	0.01296 -	3 do. do.	93.310 -
do. do.	0.01620 -	4 do. do.	124.414 -
do. do.	0.02160 -	5 do. do.	155.517 +
do. do.	0.03240 -	6 do. do.	186.621 -
do. do.	0.04860 -	7 do. do.	217.724 -
do. do.	0.06480 -	8 do. do.	248.823 -
1½ troy grains are equal to	0.09720 -	9 do. do.	279.931 +
2 do. do.	0.12960 -	10 do. do.	311.035 -
2½ do. do.	0.16200 -	11 do. do.	342.138 +
3 do. do.	0.19440 -	12 do. do.	373.250 -
4 do. do.	0.25920 -	13 do. do.	404.345 +
5 do. do.	0.32399 +	14 do. do.	435.449 -
6 do. do.	0.38879 -	15 do. do.	466.552 +
7 do. do.	0.45359 -	16 do. do.	497.656 -
8 do. do.	0.51839 -	17 do. do.	528.759 +
9 do. do.	0.58319 +	18 do. do.	559.863 +
10 do. do.	0.64799 -	19 do. do.	590.966 -
11 do. do.	0.71207 -	20 do. do.	622.070 -
12 do. do.	0.77759 -	21 do. do.	653.173 +
13 do. do.	0.84239 -	22 do. do.	684.277 -
14 do. do.	0.90718 +	23 do. do.	715.380 +
15 do. do.	0.97198 +	24 do. do.	746.499 +
16 do. do.	1.037 -	25 do. do.	779.587 +
17 do. do.	1.102 -	26 do. do.	808.691 -
18 do. do.	1.166 +	27 do. do.	839.794 +
19 do. do.	1.231 +	28 do. do.	870.898 -
20 do. do.	1.296 -	29 do. do.	902.001 +
21 do. do.	1.361 -	30 do. do.	933.105 -
22 do. do.	1.426 -	40 do. do.	1244.14 +
23 do. do.	1.458 -	50 do. do.	1555.17 +
24 do. do.	1.555 +	100 do. do.	3110.35 -

G.—RELATION OF METRIC TO AVOIRDUPOIS WEIGHTS.

	Grains.
1 gram is equal to	15.432 +
2 grams are equal to	30.865 -
3 do. do.	46.297 +
4 do. do.	61.729 +
5 do. do.	77.162 -
6 do. do.	92.594 +
7 do. do.	108.026 +
8 do. do.	123.459 -
9 do. do.	138.891 +
10 do. do.	154.323 +
11 do. do.	169.756 -
12 do. do.	185.188 +
13 do. do.	200.621 -
14 do. do.	216.053 -
15 do. do.	231.485 +
16 do. do.	246.92 -
17 do. do.	262.35 +
18 do. do.	277.73 +
19 do. do.	293.22 -
20 do. do.	308.63 -
21 do. do.	324.08 -
22 do. do.	339.51 +
23 do. do.	354.94 +
24 do. do.	370.38 -
25 do. do.	385.81 -
26 do. do.	401.24 +
27 do. do.	416.67 +
28 do. do.	432.11 -
29 do. do.	1 ounce and 10 grains.
30 do. do.	1 ounce and 25½ grains.
31 do. do.	1 ounce and 41 grains.
32 do. do.	1 ounce and 56½ grains.
33 do. do.	1 ounce and 72 grains.
34 do. do.	1 ounce and 87½ grains.
35 do. do.	1 ounce and 103 grains.
36 do. do.	1 ounce and 118 grains.
37 do. do.	1 ounce and 133½ grains.
38 do. do.	1 ounce and 149 grains.
39 do. do.	1 ounce and 164½ grains.
40 do. do.	1 ounce and 180 grains.
50 do. do.	1 ounce and 334 grains.
60 do. do.	2 ounces and 50½ grains.
70 do. do.	2 ounces and 205 grains.
80 do. do.	2 ounces and 339 grains.
90 do. do.	3 ounces and 76½ grains.
100 do. do.	3 ounces and 135 grains.
150 do. do.	4 ounces and 127 grains.
200 do. do.	7 ounces and 24 grains.
250 do. do.	8 ounces and 358 grains.
300 do. do.	10 ounces and 255 grains.
400 do. do.	14 ounces and 45 grains.
500 do. do.	17 ounces and 279 grains.
1900 do. do.	35 ounces and 120 grains.

A METRIC POSOLOGICAL TABLE, IN WHICH THE DOSES ARE EXPRESSED IN TERMS OF BOTH THE APOTHECARIES' AND THE METRIC SYSTEM OF WEIGHTS AND MEASURES.

[The GRAM and the CUBIC CENTIMETER, when referring to liquids, may be considered as equal quantities, except the liquids be very heavy or very light. The average "DROP" (water) may be considered equal to 0.05 C. C. or 0.05 Gm. An average TEASPOON holds 5 C. C., and an average TABLESPOON 20 C. C. It is safe to prescribe 30 Gm. for a troy ounce, and 250 C. C. for 8 fluid ounces.]

*Posological table.**

[Including the United States and British Pharmacopoeias, and several non-official remedies in general use.]

	Gm.
1/16 avoirdupois ounce is equal to	1.772
1/8 do. do. do	3.544
1/4 do. do	7.088
1/2 do. do	14.175
1 do. do	28.350
2 avoirdupois ounces are equal to	56.699
3 do. do	85.049
4 do. do	113.398
5 do. do	141.748
6 do. do	170.098
7 do. do	198.447
8 do. do	226.796
9 do. do	255.146
10 do. do	283.496
11 do. do	311.846
12 do. do	340.195
13 do. do	368.544
14 do. do	396.894
15 do. do	425.243
1 avoirdupois pound is equal to	453.592
2 avoirdupois pounds are equal to	907.18
3 do. do	1,360.78
4 do. do	1,814.37
5 do. do	2,267.96
6 do. do	2,721.55
7 avoirdupois pounds are equal to	3,175.14
8 do. do	3,628.74
9 do. do	4,082.33
10 do. do	4,535.92
11 do. do	4,089.52

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms. [†]
Acet. distillat.	1 to 2 fl. dr.	4 to 8 C. C.
Acet. lobellie.	30 to 60 min.	2 to 4 C. C.
Acet. opii.	7 to 10 min.	0.40 to 0.60 C. C.
Acet. sanguinal.	15 to 60 min.	1 to 4 C. C.
Acet. scille.	15 to 40 min.	1 to 2.50 C. C.
Acid. acet. dil.	1 to 2 fl. dr.	4 to 8 C. C.
Acid. arsenios.	1/2 to 1/2 gr.	0.001 to 0.005 Gm.
Acid. benzolic.	5 to 15 gr.	0.30 to 1 Gm.
Acid. boric.	5 to 10 gr.	0.30 to 0.60 Gm.
Acid. carbolic.	1 to 3 gr.	0.05 to 0.20 Gm.
Acid. citric.	10 to 30 gr.	0.50 to 2 Gm.
Acid. galli.	3 to 15 gr.	0.20 to 1 Gm.
Acid. hydrotr.	10 to 60 gr. in albuminuria.	0.50 to 4 Gm. in albuminuria.
Acid. hydrobromic.	15 to 30 gr.	1 to 2 Gm.
Acid. hydrocyan. dil.	40 gr. to 2 dr.	2 to 8 Gm.
Acid. lactic.	2 to 8 min.	0.10 to 0.50 C. C.
Acid. mur. conc.	1 to 3 dr.	4 to 12 Gm.
Acid. mur. dil.	3 to 10 gr.	0.20 to 0.60 Gm.
Acid. nitr. conc.	10 to 30 min.	0.50 to 2 C. C.
Acid. nitr. dil.	3 to 10 gr.	0.20 to 0.60 Gm.
Acid. nitromur. dil.	10 to 30 min.	0.25 to 1.50 C. C.
Acid. phosphoric. dil.	5 to 20 min.	0.50 to 4 C. C.
Acid. phosph. glae.	10 to 60 min.	0.50 to 2 Gm.
Acid. salicylic.	1 to 2 gr.	0.05 to 0.12 Gm.
Acid. sulph. arom.	5 to 15 gr.	0.30 to 1 Gm.
Acid. sulph. conc.	5 to 30 min.	0.25 to 2 C. C.
Acid. sulph. dil.	5 to 15 gr.	0.30 to 0.60 Gm.
Acid. sulphuric.	5 to 30 min.	0.25 to 2 C. C.
Acid. tannic.	30 to 60 min.	2 to 4 C. C.
Acid. tartario.	2 to 10 gr.	0.10 to 0.60 Gm.
Acconit.	10 to 30 gr.	0.50 to 2 Gm.
Aether fortior.	1/2 to 1/2 gr.	0.00015 to 0.0010 Gm.
Aether acetic.	20 to 40 min.	1.50 to 3 C. C.
Aloi. barbaj.	20 to 60 min.	1.50 to 4 C. C.
Aloi. purificate.	2 to 4 gr.	0.10 to 0.30 Gm.
Aloi. socotrina.	2 to 4 gr.	0.10 to 0.30 Gm.
Aloinum.	3 to 6 gr.	0.15 to 0.40 Gm.
Alumen.	1 to 3 gr.	0.03 to 0.20 Gm.
Ammoniacum.	10 to 15 gr.	0.50 to 1 Gm.
Ammonii benzoas.	10 to 20 gr.	0.50 to 1.30 Gm.
Ammonii bromid.	2 to 20 gr.	0.10 to 1.30 Gm.
Ammonii carb.	3 to 10 gr.	0.15 to 0.60 Gm.
Ammonii chlorid.	10 to 30 gr.	0.50 to 2 Gm.
Ammonii iodid.	2 to 5 gr.	0.10 to 0.40 Gm.
Ammonii phosph.	5 to 20 gr.	0.30 to 1.30 Gm.
Ammonii picras.	1 to 2 gr.	0.05 to 0.12 Gm.
Ammonii valer.	5 to 10 gr.	0.30 to 0.60 Gm.
Amyl nitris.	2 to 5 min.	0.10 to 0.40 C. C.

* Compiled chiefly from Squire's Companion to the British Pharmacopoeia, 10th edition, and from the United States Dispensatory.

[†] It will be seen that the doses as given in metric terms are not the exact equivalents of the doses given in apothecaries' weights and measures, nor are they in all cases the equivalents arrived at by the rules given in the preceding pages; but the differences are insignificant and on the safe side—one object aimed at being to avoid complex fractions.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Ant. et pot. tarrt.	Diaphoretic, $\frac{1}{2}$ to $\frac{1}{4}$ gr.	0.004 to 0.01 Gm.
Antimonii oxid.	1 to 3 gr.	0.05 to 0.10 Gm.
Antim. oxysulphur.	1 to 5 gr.	0.05 to 0.30 Gm.
Ant. sulphurat.	1 to 5 gr.	0.05 to 0.30 Gm.
Apomorphia	$\frac{1}{2}$ to $\frac{1}{2}$ gr.	0.003 to 0.006 Gm.
Aqua ammoniae.	10 to 20 min.	0.50 to 1.30 C. C.
Aqua am. ygd. amar.	3 to 4 fl. dr.	10 to 15 C. C.
Aqua anisi.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua aurant. flor.	$\frac{1}{2}$ to 1 fl. oz.	15 to 30 C. C.
Aqua camphora.	$\frac{1}{2}$ to 2 fl. oz.	15 to 60 C. C.
Aqua carui.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua chlorini.	1 to 4 fl. dr.	4 to 15 C. C.
Aqua cinnamomi.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua creosoti.	1 to 4 fl. dr.	4 to 15 C. C.
Aqua feniculi.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua laurocerasi.	5 to 30 min.	0.30 to 2 C. C.
Aqua menthe pip.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua menth. vir.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua picis liqu.	2 to 4 fl. oz.	60 to 125 C. C.
Aqua pimente.	1 to 2 fl. oz.	30 to 60 C. C.
Aqua rosea.	1 to 2 fl. oz.	30 to 60 C. C.
Argenti nitras.	$\frac{1}{2}$ to $\frac{1}{2}$ gr.	0.01 to 0.02 Gm.
Argenti oxid.	2 to 2 gr.	0.03 to 0.10 Gm.
Arsenici iodidi.	$\frac{1}{2}$ to $\frac{1}{2}$ gr.	0.0015 to 0.0025 Gm.
Atropis sulphas.	10 to $\frac{1}{2}$ gr.	0.0006 to 0.005 Gm.
A safetida.	10 to 15 gr.	0.30 to 1.30 Gm.
Bals. peruv.	10 to 15 min.	0.50 to 1 C. C.
Bals. tolut.	10 to 20 gr.	0.50 to 1.30 Gm.
Beberis sulphas.	1 to 10 gr.	0.05 to 0.60 Gm.
Bellad. fol.	1 to 5 gr.	0.05 to 0.30 Gm.
Bism. et ammon. citr.	1 to 2 gr.	0.05 to 0.12 Gm.
Bismuthi subearb.	5 to 20 gr.	0.30 to 1.30 Gm.
Bismuthi subnit.	5 to 15 gr.	0.30 to 1.00 Gm.
Bismuthi valer.	5 to 2 gr.	0.03 to 0.12 Gm.
Borax.	5 to 30 gr.	0.30 to 2 Gm.
Brayera.	2 to 4 dr.	8 to 15 Gm.
Brucia.	3 to 1 gr.	0.002 to 0.004 Gm.
Buchu.	20 to 30 gr.	1.00 to 3 Gm.
Caffeia.	1 to 9 gr.	0.05 to 0.12 Gm.
Calcii carb. præcip.	10 to 100 gr.	0.50 to 6.00 Gm.
Calcii hypophosphis.	5 to 10 gr.	0.30 to 0.60 Gm.
Calcii iodid.	1 to 3 gr.	0.05 to 0.20 Gm.
Calcii phosph. præcip.	10 to 40 gr.	0.50 to 3 Gm.
Calcii sulphuret.	1 to 1 gr.	0.015 to 0.040 Gm.
Calx chlorinata.	3 to 6 gr.	0.20 to 0.40 Gm.
Camphora.	2 to 10 gr.	0.10 to 0.60 Gm.
Campb. brom.	2 to 5 gr.	0.12 to 0.30 Gm.
Canella.	15 to 30 gr.	1 to 2 Gm.
Cantharis.	$\frac{1}{2}$ to 2 gr.	0.03 to 0.12 Gm.
Capsicum.	$\frac{1}{2}$ to 1 gr.	0.03 to 0.06 Gm.
Carbo lign.	20 to 60 gr.	1.00 to 4 Gm.
Cardamomum.	5 to 20 gr.	0.30 to 1.60 Gm.
Caryophyllum.	5 to 10 gr.	0.30 to 1.60 Gm.
Cascaria.	10 to 30 gr.	0.50 to 2 Gm.
Castoreum.	5 to 10 gr.	0.30 to 0.60 Gm.
Catechu.	10 to 30 gr.	0.50 to 1.60 Gm.
Ceril oxalas.	1 to 2 gr.	0.05 to 0.12 Gm.
Chalreta.	10 to 30 gr.	0.50 to 2 Gm.
Chloral hydrate.	5 to 20 gr.	0.30 to 1.30 Gm.
Chlorodrake.	5 to 20 min.	0.30 to 1.30 C. C.
Chloroformum.	1 to 5 min.	0.05 to 0.30 C. C.
Chinchone cort.	10 to 60 gr.	0.50 to 4 Gm.
Chinchone sulph.	1 to 20 gr.	0.05 to 1.30 Gm.
Chinchonide sulph.	1 to 20 gr.	0.05 to 1.30 Gm.
Cinnamon.	10 to 30 gr.	0.50 to 2 Gm.
Codeia.	1 to 2 gr.	0.05 to 0.12 Gm.
Colchici rad.	2 to 5 gr.	0.10 to 0.50 Gm.
Colchici sem.	2 to 10 gr.	0.10 to 0.60 Gm.
Colecytialis.	2 to 8 gr.	0.10 to 0.50 Gm.
Columba.	10 to 20 gr.	0.50 to 1.30 Gm.
Com. aromat.	10 to 60 gr.	0.50 to 4 Gm.
Conf. opii.	5 to 20 gr.	0.30 to 1.30 Gm.
Conf. piperis.	1 to 2 dr.	4 to 8 Gm.
Conf. rose.	$\frac{1}{2}$ to 1 dr.	2 to 4 Gm.
Conf. scammoni.	10 to 30 gr.	0.50 to 2 Gm.
Conf. sennae.	1 to 2 dr.	4 to 8 Gm.
Conf. sulphuris.	2 to 4 dr.	8 to 15 Gm.
Couia.	$\frac{1}{2}$ to $\frac{1}{2}$ gr.	0.003 to 0.005 Gm.
Copaiba.	20 to 60 min.	1 to 4 C. C.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Coriandrum.	20 to 60 gr.	1 to 4 Gm.
Cresotum.	1 to 3 min.	0.05 to 0.20 C. C.
Creta preparata.	10 to 100 gr.	0.50 to 6 Gm.
Croton chloral hydr.	1 to 10 gr.	0.05 to 0.60 Gm.
Cubeba.	1 to 2 gr.	4 to 8 Gm.
Cupri acetas.	4 to 6 gr.	0.03 to 0.49 Gm.
Cupri sulphas.	4 to 10 gr.	0.03 to 0.60 Gm.
Cuprum ammoniat.	4 to 12 gr.	0.015 to 0.03 Gm.
Cusparia.	10 to 40 gr.	0.50 to 3 Gm.
Cypripedium.	10 to 20 gr.	0.60 to 1.30 Gm.
Cypripedium.	4 to 3 gr.	0.03 to 0.12 Gm.
Decoct. aloës comp.	2 to 4 fl. oz.	15 to 60 C. C.
Decoct. cartrarie.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. chinaphtile.	3 to 6 fl. oz.	100 to 200 C. C.
Decoct. chinch. flav.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. chinch. rubr.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. cornus florid.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. dulcamare.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. gerbil.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. granati.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. hamatoxilli.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. hordei.	4 to 5 fl. oz.	100 to 250 C. C.
Decoct. pareiae.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. quercur.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. sarsap. comp.	2 to 6 fl. oz.	50 to 200 C. C.
Decoct. senegae.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. taraxaci.	4 to 5 fl. oz.	100 to 200 C. C.
Decoct. ulmi.	1 to 2 fl. oz.	30 to 60 C. C.
Decoct. uvar. ursi.	1 to 2 fl. oz.	0.001 to 0.002 Gm.
Digitalatinum.	1 to 2 gr.	0.03 to 0.10 Gm.
Digitalis.	1 to 20 gr.	0.50 to 1.30 Gm.
Dracontium.	1 to 3 gr.	0.004 to 0.03 Gm.
Elaterium.	1 to 3 gr.	0.0015 to 0.008 Gm.
Elateria.	1 to 3 gr.	4 to 8 C. C.
Ellix. amon. valer.	1 to 2 fl. dr.	4 to 15 C. C.
Ellix. calisaya.	1 to 4 fl. dr.	0.30 to 0.60 C. C.
Ellix. opii (McMunn).	5 to 10 min.	0.005 to 0.015 Gm.
Emetia.	1 to 2 gr.	1.00 to 2 Gm.
Ergota.	20 to 30 gr.	0.06 to 0.40 Gm.
Ergotinum.	1 to 6 gr.	0.05 to 0.15 Gm.
Extr. aconiti.	1 to 2 gr.	0.05 to 0.20 Gm.
Extr. aloës.	1 to 3 gr.	0.10 to 0.60 Gm.
Extr. anthemidis.	2 to 10 gr.	0.20 to 0.60 Gm.
Extr. artemis.	3 to 10 gr.	0.015 to 0.06 Gm.
Extr. belladonne.	1 to 2 gr.	0.015 to 0.06 Gm.
Extr. bellad. al.	1 to 1 gr.	0.015 to 0.06 Gm.
Extr. cannab. ind.	1 to 30 gr.	0.50 to 2 Gm.
Extr. chinchone.	1 to 2 gr.	0.05 to 0.15 Gm.
Extr. colch. acet.	2 to 5 gr.	0.10 to 0.35 Gm.
Extr. coloc. comp.	2 to 5 gr.	0.10 to 0.60 Gm.
Extr. columbo.	2 to 4 gr.	0.10 to 1.30 Gm.
Extr. com.	1 to 2 gr.	0.05 to 0.15 Gm.
Extr. conii alic.	1 to 1 gr.	0.008 to 0.016 Gm.
Extr. digitalis.	5 to 10 gr.	0.30 to 0.60 Gm.
Extr. dulcamare.	10 to 24 gr.	0.50 to 1.50 Gm.
Extr. fil. mar. aether.	10 to 12 gr.	0.50 to 1 Gm.
Extr. gentiane.	30 to 60 gr.	2 to 4 Gm.
Extr. glycyrrh.	10 to 30 gr.	0.50 to 2 Gm.
Extr. haematoxilli.	5 to 10 gr.	0.30 to 0.60 Gm.
Extr. hellebori.	3 to 8 gr.	0.20 to 0.50 Gm.
Extr. hyoscyani.	1 to 2 gr.	0.05 to 0.15 Gm.
Extr. hyoscyani ac.	5 to 12 gr.	0.03 to 0.10 Gm.
Extr. ignatiae.	5 to 15 gr.	0.30 to 1 Gm.
Extr. jalape.	20 to 30 gr.	1 to 2 Gm.
Extr. lugdani.	5 to 20 gr.	0.30 to 1.30 Gm.
Extr. Kramerie.	5 to 10 gr.	0.30 to 0.60 Gm.
Extr. lactuce.	5 to 10 gr.	0.30 to 0.60 Gm.
Extr. laevigati.	5 to 10 gr.	0.02 to 0.06 Gm.
Extr. nuc. vom.	1 to 1 gr.	0.03 to 0.06 Gm.
Extr. opii.	5 to 5 gr.	0.10 to 0.30 Gm.
Extr. pavonis.	10 to 20 gr.	0.50 to 1.50 Gm.
Extr. peruviae.	10 to 20 gr.	0.00 to 0.015 Gm.
Extr. physostigmatis.	5 to 15 gr.	0.30 to 1 Gm.
Extr. podostylli.	5 to 15 gr.	0.21 to 0.30 Gm.
Extr. quassiae.	3 to 5 gr.	0.20 to 0.60 Gm.
Extr. rhei.	3 to 10 gr.	0.05 to 0.20 Gm.
Extr. senege.	1 to 3 gr.	0.015 to 0.030 Gm.
Extr. stramon. fol.	4 to 4 gr.	0.015 to 0.030 Gm.
Extr. stramon. sem.	4 to 4 gr.	0.615 to 0.030 Gm.
Extr. taraxaci.	5 to 15 gr.	0.30 to 1 Gm.

Posological table.—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Extr. va'rianae.	10 to 30 gr.	0.50 to 2 Gm.
Extr. bellad. rad. fl.	1 to 2 min.	0.05 to 0.12 C. C.
Extr. buchu fl.	20 to 30 min.	1 to 2 C. C.
Extr. castanea fl.	1 to 3 fl. dr.	4 to 10 C. C.
Extr. chimaphile fl.	20 to 40 min.	1 to 3 C. C.
Extr. chinchone fl.	10 to 30 min.	0.50 to 2 C. C.
Extr. chivette fl.	10 to 30 min.	0.50 to 2 C. C.
Extr. cimicifuge fl.	30 to 60 min.	2 to 4 C. C.
Extr. coeca fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. coelch. rad. fl.	2 to 5 min.	0.10 to 0.30 C. C.
Extr. coelch. sem. fl.	2 to 8 min.	0.10 to 0.50 C. C.
Extr. columbo fl.	15 to 30 min.	1 to 2 C. C.
Extr. conii fruct. fl.	2 to 6 min.	0.10 to 0.40 C. C.
Extr. cornus flor. fl.	15 to 40 min.	1 to 3 C. C.
Extr. cubebe fl.	10 to 40 min.	0.50 to 3 C. C.
Extr. damiana fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. digitalis fl.	2 to 6 min.	0.10 to 0.40 C. C.
Extr. dulcamara fl.	30 to 60 min.	2 to 4 C. C.
Extr. ergote fl.	15 to 30 min.	1 to 2 C. C.
Extr. erg. can. fl.	30 to 60 min.	2 to 4 C. C.
Extr. eucalypt. glob. fl.	30 min. to 1 fl. dr.	2 to 4 C. C.
Extr. gelsemi fl.	2 to 3 min.	0.10 to 0.20 C. C.
Extr. gentianae fl.	10 to 40 min.	0.50 to 3 C. C.
Extr. gerani fl.	30 to 60 min.	2 to 4 C. C.
Extr. glycyrrh. fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. gossypii rad. fl.	30 to 60 min.	2 to 4 C. C.
Extr. grind. rob. fl.	1 to 4 fl. dr.	4 to 15 C. C.
Extr. hydrast. fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. hyoscyami fl.	5 to 10 min.	0.10 to 0.60 C. C.
Extr. ipecac. fl.	15 to 30 min.	1 to 2 C. C.
Extr. jaborandi fl.	1 to 4 fl. dr.	4 to 15 C. C.
Extr. kramer. fl.	20 to 30 min.	1 to 2 C. C.
Extr. leptandra fl.	30 to 60 min.	2 to 4 C. C.
Extr. lupulina fl.	10 to 15 min.	0.50 to 1 C. C.
Extr. maticea fl.	30 to 60 min.	2 to 4 C. C.
Extr. pareira fl.	1 to 2 fl. dr.	2 to 8 C. C.
Extr. prun. virg. fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. rhei fl.	10 to 30 min.	0.50 to 2 C. C.
Extr. rubi fl.	30 to 60 min.	2 to 4 C. C.
Extr. sabina fl.	4 to 8 min.	0.25 to 0.50 C. C.
Extr. sarsap. comp. fl.	30 to 60 min.	2 to 4 C. C.
Extr. sarsap. fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. scillae fl.	2 to 3 min.	0.10 to 0.20 C. C.
Extr. scorpari fl.	1 to 4 fl. dr.	4 to 15 C. C.
Extr. senegae fl.	1 to 5 min.	0.05 to 0.30 C. C.
Extr. sennea fl.	1 to 4 fl. dr.	4 to 15 C. C.
Extr. serpent. fl.	20 to 30 min.	1 to 2 C. C.
Extr. spig. et sen. fl.	2 to 4 fl. dr.	8 to 15 C. C.
Extr. spigelia fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. stilling. fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. taraxaci fl.	1 to 2 fl. dr.	4 to 8 C. C.
Extr. uve ursi fl.	30 to 60 min.	2 to 4 C. C.
Extr. valeriana fl.	30 to 60 min.	2 to 4 C. C.
Extr. verat. vir. fl.	2 to 4 min.	0.10 to 0.30 C. C.
Extr. visc. ali. fl.	2 to 6 fl. dr.	8 to 25 C. C.
Extr. verb. sant. fl.	1 to 4 fl. dr.	4 to 15 C. C.
Extr. zingiber. fl.	10 to 20 min.	0.50 to 1.30 Gm.
Fel. bovin. purif.	3 to 6 gr.	0.20 to 0.40 Gm.
Ferri arsenias.	1 to 1 gr.	0.004 to 0.06 Gm.
Ferri bromid.	1 to 5 gr.	0.05 to 0.30 Gm.
Ferri carb. saech.	5 to 20 gr.	0.30 to 1.30 Gm.
Ferri chlorid.	2 to 5 gr.	0.10 to 0.30 Gm.
Ferri citras.	5 to 10 gr.	0.30 to 0.60 Gm.
Ferri et ammon. citr.	5 to 10 gr.	0.30 to 0.60 Gm.
Ferri et amm. sulph.	5 to 15 gr.	0.30 to 1 Gm.
Ferri et ammon. tart.	10 to 30 gr.	0.50 to 2 Gm.
Ferri et potass. tart.	10 to 30 gr.	0.50 to 2 Gm.
Ferri et quin. citr.	5 to 10 gr.	0.30 to 0.60 Gm.
Ferri et strychn. citr.	3 to 5 gr.	0.20 to 0.30 Gm.
Ferri ferrocyanidum.	3 to 5 gr.	0.20 to 0.30 Gm.
Ferri iodidum.	1 to 5 gr.	0.05 to 0.20 Gm.
Ferri lactas.	1 to 5 gr.	0.05 to 0.20 Gm.
Ferri oxalas.	2 to 3 gr.	0.10 to 0.20 Gm.
Ferri oxid. magnet.	5 to 10 gr.	0.30 to 0.60 Gm.
Ferri oxid. hydr.	5 to 30 gr.	0.30 to 2 Gm.
Ferri phosphas.	5 to 10 gr.	0.30 to 0.60 Gm.
Ferri pyrophosphas.	2 to 5 gr.	0.10 to 0.30 Gm.
Ferri subcarbonas.	5 to 30 gr.	0.30 to 2 Gm.
Ferri sulphas.	3 to 5 gr.	0.20 to 0.30 Gm.
Ferri sulphas exsic.	1 to 3 gr.	0.03 to 0.20 Gm.

Posological table.—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Ferrum dialysat.	5 to 30 min.	0.30 to 2 C. C.
Ferrum reductum.	1 to 5 gr.	0.05 to 0.30 Gm.
Filix mas.	1 to 3 dr.	4 to 10 Gm.
Galla.	10 to 20 gr.	0.50 to 1.30 Gm.
Gambogium.	1 to 4 gr.	0.05 to 0.25 Gm.
Gentiana.	10 to 40 gr.	0.50 to 3 Gm.
Geranium.	10 to 20 gr.	0.50 to 1.30 Gm.
Gillenia.	20 to 30 gr.	1.20 to 2 Gm.
Glycerinum.	10 to 60 min.	0.50 to 4 C. C.
Glycerit. acid. carbol.	5 to 10 min.	0.30 to 0.60 C. C.
Glycerit. acid. gallici.	20 to 60 min.	1 to 4 C. C.
Glycerit. acid. tann.	10 to 40 min.	0.50 to 3 C. C.
Guaiac. resin.	10 to 30 gr.	0.50 to 2 Gm.
Guarana.	10 to 20 gr.	0.50 to 1.30 Gm.
Hydrarg. chlorid. corros.	1 to 1/2 gr.	0.004 to 0.01 Gm.
Hydrarg. chlorid. mite.	1 to 8 gr.	0.03 to 0.50 Gm.
Hydrarg. iodid. rubr.	1 to 4 gr.	0.004 to 0.015 Gm.
Hydrarg. iodid. flav.	1 to 3 gr.	0.05 to 0.20 Gm.
Hydrarg. oxid. rubr.	1 to 1 gr.	0.015 to 0.06 Gm.
Hydrarg. sulph. flav.	3 to 8 gr.	0.20 to 0.30 Gm.
Hydrarg. c. creta.	3 to 5 gr.	0.20 to 0.30 Gm.
Hydrastin.	5 to 10 gr.	0.30 to 0.60 Gm.
Hyoscyami fol.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. angusture.	1 to 3 fl. oz.	30 to 100 C. C.
Infus. anthemid.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. aurant.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. aurant. comp.	1 to 2 fl. oz.	200 to 250 C. C.
Infus. bayrese.	6 to 8 fl. oz.	30 to 60 C. C.
Infus. buchu.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. capsici.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. caryophylli.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. cascariolae.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. catechu.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. chireute.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. chinch. flav.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. chinch. rubr.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. columbo.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. coptidis.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. cuspariae.	2 to 4 fl. oz.	8 to 15 C. C.
Infus. digitalis.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. dulcamare.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. ergote.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. eupatori.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. fraseri.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. gent. comp.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. humuli.	2 to 3 fl. oz.	50 to 100 C. C.
Infus. juniperi.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. krameri.	2 to 4 fl. oz.	50 to 250 C. C.
Infus. lini. comp.	2 to 8 fl. oz.	30 to 60 C. C.
Infus. lupulina.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. matico.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. pareira.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. prun. virg.	2 to 3 fl. oz.	50 to 100 C. C.
Infus. quassie.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. rhei.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. rose comp.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. sabatiae.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. salviae.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. senegae.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. sennea.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. sennea comp.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. serpent.	4 to 8 fl. oz.	100 to 250 C. C.
Infus. spigeliae.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. taraxaci.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. uva ursi.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. valeriana.	1 to 2 fl. oz.	30 to 60 C. C.
Infus. zingiberis.	1 to 2 fl. oz.	30 to 60 C. C.
Iodinium.	1 to 1/2 gr.	0.015 to 0.03 Gm.
Ipecacuanha.	Expect. 1 to 2 gr.	0.03 to 0.13 Gm.
	Expect. 15 to 30 gr.	1 to 2 Gm.
Jaborandi.	30 to 60 gr.	2 to 4 Gm.
Jalapa.	10 to 30 gr.	0.50 to 2 Gm.
Kamala.	1 to 2 dr.	4 to 8 Gm.
Kimo.	5 to 15 gr.	0.50 to 2 Gm.
Koosine.	20 to 60 gr.	0.30 to 1 Gm.
Krameria.	20 to 60 gr.	1.20 to 4 Gm.
Leptandra.	2 to 3 fl. oz.	0.12 to 0.20 Gm.
Leptandrinum.	2 to 6 fl. dr.	8 to 25 G. C.
Liqu. ammon. acet.	2 to 8 min.	0.10 to 0.50 C. C.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Liqu. ars. et hydr. iod.	5 to 20 min.	0.30 to 1.30 C. C.
Liqu. bism. am. citr.	1 to 2 fl. dr.	4 to 8 C. C.
Liqu. calcis	1 to 2 fl. oz.	15 to 60 C. C.
Liqu. ferri chloridi	10 to 30 min.	0.50 to 2 C. C.
Liqu. ferri citrat	5 to 30 min.	0.30 to 1.30 C. C.
Liqu. ferri nitrat	30 to 60 min.	2 to 4 C. C.
Liqu. ferri subsulph.	5 to 15 min.	0.30 to 1 Gm.
Liqu. iodini comp.	1 to 4 min.	0.05 to 0.25 C. C.
Liqu. magnes. citr.	6 to 12 fl. oz.	150 to 350 C. C.
Liqu. morphiae acet.	10 to 30 min.	0.50 to 2 C. C.
Liqu. morph. sulph. U. S. P.	10 to 30 min.	0.50 to 2 C. C.
Liqu. morph. sulph. (Mag.)	4 to 8 min.	0.30 to 0.50 C. C.
Liqu. potasse.	15 to 60 min.	1 to 4 C. C.
Liqu. potass. arsenit.	5 to 15 min.	0.10 to 0.50 C. C.
Liqu. potass. citrat.	2 to 4 fl. dr.	8 to 15 C. C.
Liqu. sodic.	30 to 60 min.	2 to 4 C. C.
Liqu. sodii arseniat.	2 to 8 min.	0.10 to 0.50 C. C.
Lithii carb.	3 to 6 gr.	0.20 to 0.40 Gm.
Lithii citras.	5 to 10 gr.	0.30 to 0.60 Gm.
Lobeliae semen.	2 to 10 gr.	0.10 to 0.60 Gm.
Lupulina.	5 to 10 gr.	0.30 to 0.60 Gm.
Melumum's elix. opium.	5 to 10 min.	0.25 to 0.60 C. C.
Magnesia	10 to 20 gr.	0.50 to 1.90 Gm.
Magnesii carb.	10 to 30 gr.	0.50 to 2 Gm.
Magnesii sulph.	2 to 6 dr.	8 to 25 Gm.
Mangan. sulph.	5 to 20 gr.	0.30 to 1.30 Gm.
Manna	2 to 8 dr.	8 to 30 Gm.
Mist. ammon. iod.	1 to 1 fl. oz.	15 to 30 C. C.
Mist. amygdalae.	1 to 2 fl. oz.	30 to 60 C. C.
Mist. asaetidiae.	2 to 4 fl. oz.	50 to 150 C. C.
Mist. chloroformi.	1 to 1 fl. oz.	15 to 30 C. C.
Mist. creosoti.	1 to 2 fl. oz.	30 to 60 C. C.
Mist. crete.	1 to 2 fl. oz.	30 to 60 C. C.
Mist. ferr. comp.	2 to 4 fl. oz.	8 to 15 C. C.
Mist. glycyrrh. comp.	1 to 1 fl. oz.	15 to 30 C. C.
Mist. ginalae.	2 to 4 fl. oz.	8 to 15 C. C.
Mist. potass. citr.	4 to 2 fl. oz.	15 to 60 C. C.
Mist. scammon.	1 to 2 fl. oz.	30 to 60 C. C.
Mist. sennae comp.	1 to 2 fl. oz.	0.005 to 0.03 Gm.
Morpheia	1 to 2 fl. oz.	0.005 to 0.03 Gm.
Morpheia acetas.	1 to 2 fl. oz.	0.005 to 0.03 Gm.
Morpheia chlorid.	1 to 2 fl. oz.	0.005 to 0.03 Gm.
Morpheia meconas.	1 to 2 fl. oz.	0.005 to 0.05 Gm.
Morpheia sulph.	1 to 2 fl. oz.	0.005 to 0.03 Gm.
Morpheia valer.	1 to 2 fl. oz.	0.005 to 0.05 Gm.
Morphae.	5 to 10 gr.	0.30 to 0.60 Gm.
Muscula acaciae.	1 to 4 fl. dr.	4 to 8 C. C.
Mucilago ulmi.	2 to 8 fl. dr.	8 to 15 C. C.
Myristica.	20 to 30 gr.	1.20 to 2 Gm.
Myrrha.	10 to 30 gr.	0.50 to 2 Gm.
Narcissia.	1 to 1 gr.	0.03 to 0.06 Gm.
Nux vomica.	1 to 3 gr.	0.05 to 0.20 Gm.
Oleoresina capisci.	1 to 1 gr.	0.03 to 0.06 Gm.
Oleoresina embob.	5 to 30 gr.	0.30 to 2 Gm.
Oleoresina filicis.	20 to 30 gr.	1 to 2 Gm.
Oleoresina lupulinae.	2 to 5 gr.	0.10 to 0.30 Gm.
Oleoresina piperis.	1 to 2 gr.	0.05 to 0.10 Gm.
Oleoresina zingiberis.	1 to 2 gr.	0.05 to 0.10 Gm.
Ol. am. amar.	1 to 1 min.	0.015 to 0.030 C. C.
Ol. amygd. expr.	2 to 4 fl. dr.	8 to 15 C. C.
Ol. aethri.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. anisi.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. anthemid.	2 to 4 min.	0.10 to 0.25 C. C.
Ol. cajuputi.	1 to 5 min.	0.05 to 0.30 C. C.
Ol. cari.	2 to 4 min.	0.10 to 0.25 C. C.
Ol. caryophylli.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. chenopodi.	2 to 5 min.	0.10 to 0.30 C. C.
Ol. cinnamomi.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. copaibae.	5 to 30 min.	0.30 to 2 C. C.
Ol. coriandri.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. cubeba.	3 to 8 min.	0.30 to 0.50 C. C.
Ol. erigeron can.	Expect. 5 to 15 min.	0.30 to 1 C. C.
Ol. encalypt. glob.	Anti-periodic, 30 min. to 1 fl. dr.	2 to 4 C. C.
Ol. filic. mar.	20 to 30 min.	1.20 to 2 C. C.
Ol. feoniculi.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. galtheriae.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. hediond.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. juniperi.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. lavendule.	1 to 4 min.	0.05 to 0.25 C. C.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Ol. limonis.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. menti. pip.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. menth. vir.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. monarde.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. morrhue.	1 to 4 fl. dr.	4 to 15 C. C.
Ol. myristicae.	2 to 6 min.	0.10 to 0.40 C. C.
Ol. olivea.	1 to 4 fl. oz.	15 to 30 C. C.
Ol. origani.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. phosphorat.	5 to 10 min.	0.30 to 0.60 C. C.
Ol. pimentae.	1 to 3 min.	0.05 to 0.20 C. C.
Ol. succini rectif.	5 to 15 min.	0.30 to 1 C. C.
Ol. ricini.	1 to 8 fl. dr.	4 to 30 C. C.
Ol. rosmarinii.	2 to 5 min.	0.10 to 0.30 C. C.
Ol. ruta.	2 to 6 min.	0.10 to 0.40 C. C.
Ol. sabinae.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. sassafras.	1 to 4 min.	0.05 to 0.25 C. C.
Ol. terebinth.	10 to 30 min.	0.50 to 2 C. C.
Ol. tigilli.	1 to 1 min.	0.02 to 0.06 C. C.
Ol. valeriana.	1 to 3 min.	0.05 to 0.20 C. C.
Opium.	1 to 2 gr.	0.03 to 0.10 Gm.
Parreira.	30 to 60 gr.	2 to 4 Gm.
Pepsina.	2 to 8 gr.	0.10 to 0.50 Gm.
Phosphorus.	1 to 1/2 gr.	0.001 to 0.002 Gm.
Physostigme faba.	1 to 4 gr.	0.05 to 0.25 Gm.
Pilularia aloës.	4 to 8 gr.	0.25 to 0.5 Gm.
Pil. aloës et assafetid.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. aloës et ferri.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. aloës et mast.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. aloës et myrrae.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. antin. comp.	3 to 6 gr.	0.20 to 0.40 Gm.
Pil. assafetidiae.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. cathart. comp.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. col. et hyssopani.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. conii comp.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. copaibae.	15 to 60 gr.	1 to 4 Gm.
Pil. ferri carbonat.	5 to 20 gr.	0.30 to 1.30 Gm.
Pil. ferri comp.	5 to 15 gr.	0.30 to 1 Gm.
Pil. ferri iodidi.	3 to 8 gr.	0.20 to 0.50 Gm.
Pil. galbanii comp.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. hydraq.	5 to 10 gr.	0.20 to 0.60 Gm.
Pil. hyd. subchlor. ce.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. ipecac. c. scilla.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. opii.	1 1/2 to 2 gr.	0.03 to 0.10 Gm.
Pil. opii et camph.	1 1/2 to 3 gr.	0.10 to 0.20 Gm.
Pil. phosphori.	2 to 1/2 gr.	0.002 to 0.004 Gm.
Pil. plumbi c. opio.	2 to 4 gr.	0.10 to 0.25 Gm.
Pil. plumbi c. opio.	2 to 10 gr.	0.10 to 0.60 Gm.
Purgative.	25 to 40 gr.	1.50 to 3 Gm.
Laxative.	6 to 12 gr.	0.40 to 0.75 Gm.
Pil. rhei comp.	10 to 20 gr.	0.50 to 1.30 Gm.
Pil. sapon. comp.	5 to 10 gr.	0.30 to 0.60 Gm.
Pil. scammon. comp.	10 to 30 gr.	0.50 to 2 Gm.
Pil. scilla comp.	5 to 10 gr.	0.30 to 0.60 Gm.
Pilocarpinum.	1 to 1/2 gr.	0.008 to 0.016 Gm.
Pimenta.	10 to 30 gr.	0.50 to 2 Gm.
Piper.	5 to 20 gr.	0.30 to 1.30 Gm.
Piperinum.	1 to 8 gr.	0.05 to 0.50 Gm.
Pix liquida.	20 to 60 gr.	1 to 4 C. C.
Plumbi acetas.	2 to 8 gr.	0.10 to 0.50 Gm.
Podophyllum.	10 to 20 gr.	0.50 to 1.30 Gm.
Potassi acetas.	10 to 20 gr.	0.50 to 1.30 Gm.
Potass. bicarb.	10 to 20 gr.	0.50 to 1.30 Gm.
Potass. bitartr.	1 to 4 gr.	2 to 15 Gm.
Potass. bromid.	20 to 60 gr.	1 to 4 Gm.
Potass. carb.	5 to 15 gr.	0.30 to 1 Gm.
Potass. chloras.	10 to 20 gr.	0.50 to 1.30 Gm.
Potass. citrus.	20 to 60 gr.	1 to 5 Gm.
Potass. cyanid.	1 to 1/2 gr.	0.005 to 0.008 Gm.
Potass. et sod. tartr.	3 to 8 gr.	10 to 30 Gm.
Potass. iodid.	2 to 10 gr.	0.10 to 0.60 Gm.
Potass. nitras.	5 to 20 gr.	0.30 to 1.30 Gm.
Potass. sulphas.	10 to 20 gr.	0.50 to 1.30 Gm.
Potass. sulphur.	10 to 20 gr.	0.50 to 1.30 Gm.
Potass. tartras.	2 to 10 gr.	0.10 to 0.60 Gm.
Potass. sulphur.	1 to 4 gr.	2 to 15 Gm.
Potass. permanganas.	1 to 1/2 gr.	0.05 to 0.03 Gm.
Propylamina.	7 to 15 gr.	0.50 to 1 Gm.
Pulv. aloës et canellæ.	10 to 20 gr.	0.50 to 1.30 Gm.
Pulv. amygd. comp.	1 to 2 dr.	4 to 8 Gm.
Pulv. antimonialis.	2 to 6 gr.	0.10 to 0.40 Gm.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed by metric terms.
Pulv. aromaticus	3 to 10 gr.	0.20 to 0.60 Gm.
Pulv. catechu comp.	15 to 50 gr.	1 to 2 Gm.
Pulv. cinnam. comp.	3 to 10 gr.	0.20 to 0.60 Gm.
Pulv. crete arom.	30 to 60 gr.	2 to 4 Gm.
Pulv. cret. arom. c. op.	10 to 40 gr.	0.50 to 2.50 Gm.
Pulv. ipecac. comp.	5 to 10 gr.	0.20 to 0.60 Gm.
Pulv. jalape comp.	10 to 20 gr.	0.50 to 1.30 Gm.
Pulv. kino comp.	3 to 8 gr.	0.20 to 0.50 Gm.
Pulv. opii comp.	3 to 5 gr.	0.10 to 0.30 Gm.
Pulv. rheol comp.	30 to 60 gr.	2 to 4 Gm.
Pulv. scammon. comp.	10 to 20 gr.	0.50 to 1.30 Gm.
Pulv. tragac. comp.	10 to 60 gr.	0.50 to 4 Gm.
Quercus	1 to 2 dr.	2 to 8 Gm.
Quinia	1 to 5 gr.	0.05 to 0.30 Gm.
Quinia arsenias	1 to 2 gr.	0.05 to 0.12 Gm.
Quinia bromid.	1 to 5 gr.	0.05 to 0.30 Gm.
Quinia sulph	1 to 5 gr.	0.05 to 0.30 Gm.
Quinia valer.	1 to 5 gr.	0.05 to 0.30 Gm.
Resina jalape	2 to 5 gr.	0.10 to 0.30 Gm.
Resina podophylli	1 to 3 gr.	0.01 to 0.03 Gm.
Resina scammonii	4 to 6 gr.	0.25 to 0.50 Gm.
Rheum	1 to 30 gr.	0.05 to 2 Gm.
Sabadilla	4 to 6 gr.	0.25 to 0.40 Gm.
Sabina	4 to 6 gr.	0.25 to 0.40 Gm.
Salicinum	10 to 30 gr.	0.50 to 2 Gm.
Sanguinaria	10 to 20 gr.	0.30 to 1.30 Gm.
Santonica	10 to 60 gr.	0.50 to 4 Gm.
Santoninum	2 to 6 gr.	0.10 to 0.30 Gm.
Sapo	5 to 15 gr.	0.30 to 1 Gm.
Scammonium	4 to 10 gr.	0.25 to 0.60 Gm.
Scilla	1 to 2 gr.	0.05 to 0.10 Gm.
Scoparius	20 to 60 gr.	1.20 to 4 Gm.
Senega	15 to 20 gr.	1 to 1.30 Gm.
Senna	10 to 30 gr.	0.50 to 2 Gm.
Serpentaria	10 to 15 gr.	0.50 to 1 Gm.
Sodii acetas.	20 to 60 gr.	1 to 1 Gm.
Sodii arsenias.	1 to 1/2 gr.	0.004 to 0.008 Gm.
Sodii biberas.	10 to 30 gr.	0.50 to 2 Gm.
Sodii bicarb.	10 to 30 gr.	0.50 to 2 Gm.
Sodii bisulphis.	10 to 20 gr.	0.50 to 1.30 Gm.
Sodii carbonas.	10 to 30 gr.	0.50 to 2 Gm.
Sodii carb. exsicc.	5 to 20 gr.	0.30 to 1.30 Gm.
Sodii chloras.	5 to 30 gr.	0.30 to 2 Gm.
Sodii hypophosphis.	10 to 30 gr.	0.50 to 2 Gm.
Sodii iodo.	15 to 30 gr.	1 to 2 Gm.
Sodii phosphas.	2 to 8 gr.	0.10 to 0.50 Gm.
Sodii sulphis.	10 to 30 gr.	0.50 to 2 Gm.
Sodii sulphuret.	1 to 1/2 gr.	0.016 to 0.06 Gm.
Spir. aetheris comp.	30 to 60 min.	2 to 4 C. C.
Spir. aetheris nitros.	1 to 2 fl. dr.	2 to 8 C. C.
Spir. ammon.	30 to 30 min.	0.50 to 2 C. C.
Spir. ammon. arom.	30 to 60 min.	1 to 4 C. C.
Spir. ammon. fetid.	30 to 60 min.	2 to 4 C. C.
Spir. armacie. comp.	1 to 3 fl. dr.	4 to 12 C. C.
Spir. anisi.	30 to 60 min.	2 to 4 C. C.
Spir. cajuputi.	30 to 60 min.	2 to 4 C. C.
Spir. camphore.	10 to 30 min.	0.50 to 2 C. C.
Spir. chloroformi.	20 to 60 min.	1 to 4 C. C.
Spir. cinnamomi.	30 to 60 min.	2 to 4 C. C.
Spir. juniperi.	30 to 60 min.	2 to 4 C. C.
Spir. juniperi comp.	30 to 60 min.	2 to 4 C. C.
Spir. lavendule.	30 to 60 min.	2 to 4 C. C.
Spir. lavend. comp.	30 to 60 min.	2 to 4 C. C.
Spir. limonis.	30 to 60 min.	2 to 4 C. C.
Spir. menth. pip.	30 to 60 min.	2 to 4 C. C.
Spir. menth. vir.	30 to 60 min.	2 to 4 C. C.
Spir. myristice.	30 to 60 min.	2 to 4 C. C.
Spir. rosmarinii.	10 to 30 min.	0.50 to 2 C. C.
Stram. fol.	9 to 3 gr.	1.10 to 0.30 Gm.
Stram. sem.	1 to 2 gr.	0.05 to 0.12 Gm.
Strychnia.	1 to 1/2 gr.	0.001 to 0.005 Gm.
Strychnia acet.	1 to 1/2 gr.	0.001 to 0.005 Gm.
Strychnia nitr.	1 to 1/2 gr.	0.001 to 0.005 Gm.
Strychnia sulph.	1 to 1/2 gr.	0.001 to 0.005 Gm.
Succus conii.	30 to 60 min.	2 to 4 C. C.
Succus limonis.	2 to 4 fl. oz.	2 to 15 C. C.
Succus taraxaci.	2 to 2 dr.	2 to 8 Gm.
Sulphur precipit.	1 to 4 dr.	2 to 15 Gm.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Sulph. subl. lot.	1 to 4 dr.	2 to 15 Gm.
Syr. acacie.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. acid. citr.	1 to 4 fl. dr.	4 to 15 C. C.
Syr. alli.	1 to 4 fl. dr.	4 to 15 C. C.
Syr. althaea.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. amygd.	1 to 4 fl. dr.	4 to 15 C. C.
Syr. aurant. cort.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. aurant. flor.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. ferri bromidi.	20 to 60 min.	1 to 4 G. C.
Syr. ferri iodidi.	20 to 60 min.	1 to 4 C. C.
Syr. hemidesmi.	1 to 4 fl. dr.	4 to 15 C. C.
Syr. hypophosphit.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. ipecacuanha.	Emet. 4 to 8 fl. dr.	15 to 30 C. C.
Syr. lactumeria.	Expect. 1/2 to 1 fl. dr.	2 to 4 C. C.
Syr. limonis.	1/2 to 3 fl. dr.	8 to 12 C. C.
Syr. mirri.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. papaveris.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. phosphat. comp.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. prun. virg.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. sambuci.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. sanguinaria.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. rhei.	1 to 2 fl. dr.	4 to 15 C. C.
Syr. rhei arom.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. rheeados.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. rose.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. rubi.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. sarsap. comp.	1 to 2 fl. dr.	4 to 15 C. C.
Syr. scillae.	1/2 to 1 fl. dr.	2 to 4 C. C.
Syr. scille comp.	10 to 60 min.	0.50 to 4 C. C.
Syr. senega.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. sennae.	1 to 2 fl. dr.	4 to 8 C. C.
Syr. tolnt.	1 to 2 fl. dr.	4 to 8 C. C.
Tamar ind.	1 to 4 fl. dr.	4 to 8 Gm.
Theia.	1 to 2 gr.	0.05 to 0.12 Gm.
Tinct. aconiti fol.	10 to 20 min.	0.50 to 1.30 C. C.
Tinct. aconit. rad.	5 to 15 min.	0.30 to 1 C. C.
Tinct. acon. rad. Flem.	2 to 3 min.	0.10 to 0.20 C. C.
Tinct. aloes.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. aloes et myrr.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. armice.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. assafetida.	30 to 60 min.	2 to 4 C. C.
Tinct. antraniti.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. bellat.	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. benz. comp.	30 min. to 2 fl. dr.	2 to 8 C. C.
Tinct. buchu.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. cannab. ind.	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. canthar.	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. capefil.	10 to 20 min.	0.50 to 1.30 C. C.
Tinct. card. comp.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. cascara.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. castorei.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. catechu.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. chinch.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. chinch. comp.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. chritte.	1 to 2 fl. dr.	2 to 4 C. C.
Tinct. cimicifuge.	30 min. to 1 fl. dr.	2 to 4 C. C.
Tinct. cinnamon.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. cocc.	30 to 90 min.	2 to 6 C. C.
Tinct. colchici rad.	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. colchici sem.	15 to 30 min.	1 to 2 C. C.
Tinct. confi.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. copidis.	30 min. to 1 fl. dr.	2 to 4 C. C.
Tinct. croci.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. cubeba.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. damiana.	1 to 3 fl. dr.	4 to 10 C. C.
Tinct. digitalis.	10 to 30 min.	0.50 to 2 C. C.
Tinct. ergote.	15 to 60 min.	1 to 4 C. C.
Tinct. ferri acet.	5 to 30 min.	0.30 to 2 C. C.
Tinct. ferri chlorid.	10 to 30 min.	0.50 to 2 C. C.
Tinct. galla.	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. gelsemia.	2 to 15 min.	0.10 to 1 C. C.
Tinct. gent. comp.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. guaiaci.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. guaiaci am.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. hellebore.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. humuli.	1 to 3 fl. dr.	4 to 12 C. C.
Tinct. hyoscyami fol.	15 to 60 min.	1 to 4 C. C.

Posological table—Continued.

Remedies.	Dose expressed in terms of apothecaries' weights and measures.	Dose expressed in metric terms.
Tinct. hyosc. sem.	10 to 40 min.	0.50 to 3 C. C.
Tinct. iodini	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. iodini comp.	10 to 20 min.	0.50 to 1.30 C. C.
Tinct. jalape	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. kino	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. krameriae	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. lobeliae	10 to 30 min.	0.50 to 2 C. C.
Tinct. lupulinae	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. myrrae	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. nuc. vom.	10 to 30 min.	0.50 to 2 C. C.
Tinct. opii	10 to 30 min.	0.50 to 2 C. C.
Tinct. opii acet.	10 to 20 min.	0.50 to 1.30 C. C.
Tinct. opii ammon.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. opii camp.	15 to 60 min.	1 to 4 C. C.
Tinct. opii deodor.	10 to 30 min.	0.50 to 3 C. C.
Tinct. quassiae	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. quiniae	1 to 1 1/2 fl. dr.	4 to 6 C. C.
Tinct. quiniae am.	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. rhei	1 to 8 fl. dr.	4 to 30 C. C.
Tinct. rhei et sennae	1 to 2 fl. oz.	15 to 60 C. C.
Tinct. sanguinariae	3 to 4 fl. dr.	10 to 15 C. C.
Tinct. scille	15 to 30 min.	1 to 2 C. C.
Tinct. senega	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. sennae	2 to 8 fl. dr.	8 to 30 C. C.
Tinct. serpentariae	1 to 2 fl. dr.	2 to 8 C. C.
Tinct. stramon. fol.	10 to 50 min.	0.50 to 1.30 C. C.
Tinct. stramon. sem.	10 to 20 min.	0.50 to 1.30 C. C.
Tinct. sumbul.	15 to 30 min.	1 to 2 C. C.
Tinct. tolut.	15 to 40 min.	1 to 2.50 C. C.
Tinct. valerianae	1 to 2 fl. dr.	4 to 8 C. C.
Tinct. valer. ammon.	1 to 1 fl. dr.	2 to 4 C. C.
Tinct. ver. vir.	5 to 20 min.	0.30 to 1.30 C. C.
Tinct. zingiberis	10 to 30 min.	0.50 to 2 C. C.
Uva ursi	10 to 30 gr.	0.50 to 2 Gm.
Valeriana	10 to 30 gr.	0.50 to 2 Gm.
Verat. viride	4 to 6 gr.	0.25 to 0.4 Gm.
Veratrica	4 to 1/2 gr.	0.0013 to 0.010 Gm.
Vin. aloes	1 to 2 fl. dr.	4 to 8 C. C.
Vin. antimonii	10 to 60 min.	0.50 to 4 C. C.
Vin. colch. rad.	10 to 30 min.	0.50 to 2 C. C.
Vin. colch. sem.	1 to 1 fl. dr.	2 to 4 C. C.
Vin. ergota	1 to 3 fl. dr.	4 to 12 C. C.
Vin. ferri	1 to 4 fl. dr.	4 to 15 C. C.
Vin. ferri citr.	1 to 4 fl. dr.	4 to 15 C. C.
Vin. ipecac.	3 to 5 to 40 min.	0.30 to 2.50 C. C.
Vin. opii	Emet., 3 to 6 fl. dr.	12 to 20 C. C.
Vin. pic. liqu.	10 to 40 min.	0.50 to 3 C. C.
Vin. quiniae	1 to 4 fl. dr.	4 to 15 C. C.
Vin. rhei	1 to 1 fl. oz.	15 to 30 C. C.
Vin. tabaci	10 to 40 min.	0.50 to 3 C. C.
Zinci acet.	1 to 2 gr.	0.05 to 0.10 Gm.
Zinci carb.	2 to 10 gr.	0.10 to 0.60 Gm.
Zinci chlorid.	1/2 to 2 gr.	0.03 to 0.10 Gm.
Zinci oxid.	1/2 to 10 gr.	0.10 to 0.60 Gm.
Zinci phosphid.	1/2 to 1 gr.	0.005 to 0.01 Gm.
Zinci sulph.	Ton., 1 to 2 gr.	0.05 to 0.10 Gm.
Zinci valer.	Emet., 10 to 30 gr.	0.50 to 2 Gm.
Zingiber	1 to 6 gr.	0.05 to 0.40 Gm.
	10 to 20 gr.	0.50 to 1.30 Gm.

WASHINGTON, D. C.

	Millimeter.	Centimeter.	Decimeter.	Meter.	Dekameter.	Hektometer.	Kilometer.	Myriameter.
	1.0	10	100	1000	10000	100000	1000000	10000000
Millimeter	1.0	10	100	1000	10000	100000	1000000	10000000
Centimeter	0.01	0.1	1.0	10	100	1000	10000	100000
Decimeter	0.001	0.01	0.1	1	10	100	1000	10000
Meter	0.0001	0.001	0.01	0.1	1	10	100	1000
Dekameter	0.00001	0.0001	0.001	0.01	0.1	1	10	100
Hektometer	0.000001	0.00001	0.0001	0.001	0.01	0.1	1	10
Kilometer	0.0000001	0.000001	0.00001	0.0001	0.001	0.01	0.1	1
Myriameter	0.00000001	0.0000001	0.000001	0.00001	0.0001	0.001	0.01	0.1

From "Proposed substitution of the metric for our own system of weights and measures," by Persifor Frazer, Jr., A. M.

COMPARATIVE CHART OF METRIC LINEAL MEASURE.

	Millimeter.	Centimeter.	Decimeter.	Meter.	Fathoms.	Rods.	Chains.	Furlongs.	Miles (st.)	Miles (ge.)	Leagues.
	1.0	10	100	1000	216	594	2576	22076	190080	1600000	570240
Millimeter	1.0	10	100	1000	216	594	2576	22076	190080	1600000	570240
Centimeter	0.01	0.1	1.0	10	22	59	257	2207	19008	1600000	570240
Decimeter	0.001	0.01	0.1	1	2.2	5.9	25.7	22.07	19.008	1600000	570240
Meter	0.0001	0.001	0.01	0.1	0.22	0.59	2.57	2.207	1.9008	1600000	570240
Dekameter	0.00001	0.0001	0.001	0.01	0.022	0.059	0.257	0.2207	0.19008	1600000	570240
Hektometer	0.000001	0.00001	0.0001	0.001	0.0022	0.0059	0.0257	0.02207	0.019008	1600000	570240
Kilometer	0.0000001	0.000001	0.00001	0.0001	0.00022	0.00059	0.00257	0.002207	0.0019008	1600000	570240
Myriameter	0.00000001	0.0000001	0.000001	0.00001	0.000022	0.000059	0.000257	0.0002207	0.00019008	1600000	570240

COMPARATIVE CHART OF ENGLISH LONG-MEASURE.

	Barleycorns.	Inches.	Hands.	Feet.	Yards.	Fathoms.	Rods.	Chains.	Furlongs.	Miles (st.)	Miles (ge.)
	12	3	4	36	108	216	594	2576	22076	190080	1600000
Barleycorns	1.33	2.5	4	7.92	12	36	72	18	18	73892	570240
Inches	0.083	0.162	0.25	1.98	3	9	25	49.5	18	16340	190080
Hands	0.042	0.083	0.162	0.660	1	5.45	18	49.5	18	16340	47520
Feet	0.0278	0.0556	0.132	0.660	1	1.515	6	100	100	8266.66	24100
Yards	0.0092	0.0183	0.0378	0.33	3	4.545	16.5	66	66	6116	13840
Fathoms	0.0039	0.0078	0.0159	0.220	0.555	1	5.5	22	22	2038.66	3220
Rods	0.00167	0.00334	0.00671	0.0666	0.165	0.1518	1.1	2.75	11	1019.33	2640
Iards	0.00046	0.00092	0.00187	0.0162	0.0392	0.04	0.0606	0.18	4	370.66	900
Chains	0.000167	0.000334	0.000671	0.00671	0.01345	0.0162	0.0392	0.18	10	92.06	240
Furlongs	0.000046	0.000092	0.000187	0.00162	0.00325	0.00671	0.01345	0.18	1	9.266	24
Miles (st.)	0.0000046	0.0000092	0.0000187	0.000162	0.000325	0.000671	0.001345	0.18	1	1.1582	3
Miles (ge.)	0.00000046	0.00000092	0.00000187	0.0000162	0.0000325	0.0000671	0.0001345	0.18	0.16792	0.8634	1
Leagues	0.000000046	0.000000092	0.000000187	0.00000162	0.00000325	0.00000671	0.00001345	0.18	0.004166	0.3333	1

Table showing the relation of English to metric lineal units.

PREPARED BY PROFESSOR PERSIFOR FRAZER, JR.

Meters.	Meters.	Millimeters.	
0.00846	Barleycorn	0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009	1 2 3 4 5 6 7 8 9
0.0254	Inch (=3 barleycorns)	0.01 0.02	Centimeters. 1 2
0.0305	Foot tenth (=1.2 inches)	0.03	3
.05715	Nail (=2.25 inches)	0.04 0.05 0.06 0.07 0.08 0.09	4 5 6 7 8 9
0.1016	Hand (=4 inches)	0.1	Decimeters. 1
0.1558	(Cube root of wine gal. or 231 cub. in.=6.1538 in.)		
0.1665	(Cube root of beer gal. or 282 cub. in.=6.5576 in.)		
0.2012	Link (=7.92 inches) }	0.2	
0.2226	Quarter (=9 inches) }	0.3	
0.3043	Foot (=12 inches)	0.4	
0.3278	(Cube root of bushel (=1.907 inches))	0.5	
0.5715	Ell Hamburg (=2½ quarters)	0.6 0.7 0.8 0.9	6 7 8 9
0.9144	Yard (=3 feet)	1	Meters. 1
0.9837	(Cubic root of wine tun =38.78 inches)		
1.143	Ell English (=5 quarters) }	2	
1.3716	Ell French (=6 quarters) }	3	
1.5631	(Cube root of cord (=5.0397 feet))	4	
1.829	Fathom (=6 feet)	5	
5.0292	Rod, pole, or perch (=5.5 yards)	6 7 8 9	6 7 8 9
20.1164	Chain (=4 rods=22 yards)	10 20 30 40 50 60 70 80 90	Dekameters. 1 2 3 4 5 6 7 8 9
63.6148	(Square root of an acre (=69.57 yards))	100 200 300 400 500 600 700 800 900	Hectometers. 1 2 3 4 5 6 7 8 9
1609.34	Statute mile (=8 furlongs)	1000	Kilometers. 1
1863.62	Geographical mile (=1.158 statute miles)	2000 3000 4000	2 3 4
4828.02	League (=3 statute miles)	5000 6000 7000 8000 9000	5 6 7 8 9
		10000	Myriameters. 1

PART 2.

ON METRIC COINAGE.

PART 2.

METRIC COINAGE.

Mr. STEPHENS, from the Committee on Coinage, Weights, and Measures, submitted the following report on the metric coinage, to accompany the foregoing report on the metric system of weights and measures:

The several House bills, Nos. 410, 411, 412, 1519, 1911, relating to metric gold coinage, goloid coinage, an international coin denominated "one stella"; ingots of the metals gold and silver adapted for coinage, on which certificates may be issued for use as money; ingots of fine metals, for exportation and manufactures, and for the coinage of a metric silver dollar, all of full United States standard fineness, value, and denominations, are now under consideration by the committee.

The subject of metric coinage, involving some of these matters, was before the committee of the Forty-fifth Congress, and reported favorably upon at the close of the session, March 3, 1879. The whole field of coinage, in all the United States coin denominations, has since been perfected as is believed and as will appear from a completed formulation of the same, prepared by Dr. William Wheeler Hubbell for the committee, and herewith submitted to the House, marked "Exhibit A."

The origin, nature, and merit of the French metric system of weights and measures, which is now making such progress in all commercial nations, need not be recapitulated here; suffice it to say that the essential principle of the entire system is simply a decimal system of multiples and divisions, and these, of course, divisible into numerals, as extensive as the combinations of numbers, which are almost illimitable.

The application of the unit of measure of the metric system, the meter, and of the unit of weight, the gram, belongs to the report on weights and measures, so far as all measures of length, capacity, and commercial articles are concerned; this report being intended, with this prefatory explanation, to be confined to the subject of coinage.

The introduction of the metric system in coinage has been delayed for the want of a scientific metallurgical solution of its application to standard values of coin, either gold or silver.

For over half a century this subject has baffled the skill of the most eminent investigators of the civilized world. The nearest approach was that proposed in this country a few years ago, to make the gold dollar to consist of 1.5 grams of pure gold, resulting in a loss of three dollars and a fraction in a thousand dollars, and the coin when alloyed to .9 fine would not itself be in any recognized metric measure of weight. It would be $1\frac{1}{3}$ grams, and there are no thirds in the metric system; a third is not expressible in decimals.

The French gold coins are not metric, not expressed in even numerals, and the denomination in cents not in even decimal units. The French five-franc silver coin is 25 grams in weight, .9 fine. This weight is metric, but the value is 93.5 cents, not a decimal unit of denomination; and the loss is still greater, being a loss of 6.5 per cent. short of our decimal unit of one dollar, or 100 cents.

These were the nearest approaches to the great desideratum.

It was a wise foresight in the founders of our system of coinage, to place it upon the basis of decimal units of denomination, 10 cents, 25

cents, 50 cents, 100 cents, or one dollar, and even multiples of one dollar. All of our contracts, public and private, are founded on this decimal denomination of coinage, or of money.

The difficult problem has been to adapt these decimal denominations to the metric system, and still preserve their exact standard value. And it has been reserved for the honor of the United States to make this metallurgical discovery, and to solve this great complex problem, so important to the interests of the commercial world, and to present a system, decimal throughout, of exact standard values, fineness of the precious metals, embracing the use of both gold and silver on the highest plane or level of equality, on the standard practical ratio, and in even decimal denominations and multiples thereof, comprehending our entire coinage system, and rendering it suitable for all nations with whom we may trade or hold intercourse.

The invention or discovery was first made by Dr. Hubbell, in the goloid dollar of 14.25 grams in weight, which was reported to the House of Representatives, Forty-fifth Congress, second session, July 8, 1878, by Mr. Vance, from the Committee on Coinage, Weights, and Measures, Report No. 918, with a joint resolution No. 187, which unanimously passed the House, but was not reached in the Senate for final action. It required specimens to be furnished, and laid before the proposed International Congress, to fix a ratio between gold and silver.

The then Director of the Mint, Dr. H. R. Linderman, had specimen metric goloid dollars prepared and forwarded to our commissioners, as appears by his official letter of July 22, 1878, printed with a letter of July 24, 1878, from Dr. Hubbell, by order of the State Department, on request of the President of the United States.

Our established ratio of 16 to 1 in practical mintage is in accord with all of our obligations, and is claimed by expert practical men to be the best in all respects; and so thoroughly was the late Director of the Mint, Dr. Linderman, convinced of this, that instructions to this effect were sent to our then commissioners to Paris; and a late vote of the House of Representatives, by a very large majority, affirmed the propriety, substantially, of this monetary ratio.

The metric coinage system herein set forth is, at present, founded on this ratio of 16 to 1; but the principle upon which it is founded admits of any variation in weight, or in ratio, that may in future time be desired, if any, which is unlikely, as it embraces all the advantages of bi-metallic money, and more than all the benefits of mono-metallic coinages, without their disadvantages.

The next metric coinage discovered or invented by Dr. Hubbell was the "metric gold," comprising the gold double-eagle, 35 grams in weight and twenty dollars in value, and all the divisions of that denomination in United States coinage, consisting of the eagle, half-eagle, three dollars, quarter-eagle, and one dollar; this metric gold coinage, together with the goloid dollar, were reported favorably to the House of Representatives of the 45th Congress, third session, Report No. 64, on January 21, 1879, by the chairman of and from the Committee on Coinage, Weights, and Measures.

Subsequently, on January 24, 1879, the Secretary of State transmitted to the Secretary of the Treasury, dispatches of date January 3, 1879, from Hon. John A. Kasson, formerly chairman of the Committee on Coinage, Weights, and Measures, and at present minister at Vienna, in relation to a coin to express invoice values, in a unit of denomination near to the eight-florin piece, which latter coin had been allowed by the Treasury for this purpose, as a commercial convenience.

These papers were handed over by the committee to Dr. Hubbell, who worked out the problem perfectly in the metric gold coin of 400 cents even value, containing six grams of pure gold, three decigrams of pure silver, and seven decigrams of pure copper; seven grams even in total weight; closely approximating to all the foreign coin of near this denomination, and in all computations convertible into them, and into other United States coin with a single numeral, four, and absolutely metric in all respects, being one-fifth of the metric double-eagle.

A favorable report on the whole of this subject was made to the House of Representatives of the 45th Congress, third session, Report No. 136, on March 3, 1879, by the chairman of the Committee on Coinage, Weights, and Measures.

An equation of eight to one was then discovered by Dr. Hubbell between the goloid dollar and the metric gold coin, whereby the goloid dollar was made even 14 grams in weight, and the metric gold dollar 1.75 grams in weight, as originally discovered.

A metric silver dollar was then produced by him, precisely 25 grams in weight and 100 cents in value, thus overcoming the difficulty of denominational value, that existed in the French 5-franc silver-piece of this weight, and in our subsidiary silver coin of halves, quarters, and dimes, in metric weights copied from it.

This metric system of coinage is now perfected, by the inventor thereof, to include every denomination of the coins of gold and silver of the United States, .9 fine, and an international unit of denomination in the "stella," all in precise accord with every principle and condition required in United States coinage.

The specimens of the metric coin struck show superiority, the metal is tougher and more resistant to abrasion, and durable, on principles recognized in other alloys in metallurgy.

These metric coins are ternary alloys on the bi-metallic money basis; they embody a practical compensation of the precious metals in all respects, and no doubt, if adopted, will greatly facilitate the voluntary introduction and adoption in the United States of the metric system, which is already legalized by Congress, and which has been adopted by so many of the progressive nations of the earth. Its essential principle, a decimal system, is adapted to all commercial uses.

An important feature in these coins is that their weight is equally expressible in both the metric and in troy measures of weight. The two systems, metric and troy, come together on this perfected coinage basis. In illustration of this, Exhibit "B" is hereto appended.

EXHIBIT A.

WASHINGTON, D. C., May 5, 1879.

DEAR SIR: At your suggestion, I embody and append hereto an entire formulation of the perfected system of metric alloy, and coinage of gold and silver invented by myself, and respectfully submit the same for your consideration, that of the committee of which you are chairman, and of the Congress of the United States.

This entire system of metric coinage, and its auxiliary monetary representation, or equivalents, of coinage ingots and certificates, are embraced in practical form in the House bills numbers 410, 411, 412, 1911, and fine ingots for export and manufacturing use in No. 1519.

In my judgment this precious metal monetary system is now perfect in every respect, and is the full and complete realization of the metric measure of weight in standard coinage; a discovery for which the world has been looking to us, for the reason that ours was a decimal system of denominations, and the decimal is the essential

principle of the metric system, with the meter as its unit of measure, and the gram as its unit of weight, derived from the meter. I petition for its adoption.

Respectfully,

WM. WHEELER HUBBELL.

Hon. ALEXANDER H. STEPHENS,

*Chairman of the Committee on Coinage, Weights, and Measures
of the House of Representatives of the Forty-sixth Congress.*

Formulations of the metric system of coinage of gold and silver of United States denominations, standard value and fineness.

1st. METRIC GOLD COIN; RATIO OF VALUE 1 TO 16.

Parts of alloy:

Pure gold, 30 grams; pure silver, 1.5 grams; copper, 3.5 grams: total 35 grams.

Expressed in standard metals:

Standard gold, .9 fine	33.334 grams.
Standard silver, .9 fine	1.666 grams.

Weight, grams..... 35.000

Expressed in troy grains..... = 540.125 grains.

Minting proportions:

Pure gold	857.14	} = 1,000 parts.
Pure silver	42.86	
Copper	100.00	

Value of the standard gold..... \$19.938

Value of the standard silver..... 6.2

Being one double-eagle, value..... 20.00

Divisions of the double-eagle in weight and value, expressed in denominations:

One eagle	weight, 17.5 grams; value, \$10.00.
Half-eagle	weight, 8.75 grams; value, 5.00.
Three-dollar coin	weight, 5.25 grams; value, 3.00.
Quarter-eagle	weight, 4.375 grams; value, 2.50.
One dollar	weight, 1.75 grams; value, 1.00.
One stella	weight, 7 grams; value, 4.00.

I do not advise metric gold coin of less value than \$4. The denomination of "one stella" is the proposed new unit of denomination for invoice valuations, into which, it being even 400 cents in value, the units of value of all nations, and their approximate coin, in hundreds or thousands, are readily convertible, and to which they may be easily made precisely conformable, and thus adopt our decimal system for all invoice values. Gold coins less than \$4 are too small for convenient use, too expensive and difficult to adjust in mintage, and wear away too rapidly.

2. METRIC GOLOID COIN; RATIO OF VALUE 1 TO 16.

Parts of alloy:

Pure gold 76.5 centigrams; pure silver 11.835 grams; copper 1.4 grams: total 14 grams.

Expressed in standard metals:

Standard gold, .9 fine	.85 centigrams.
Standard silver, .9 fine	13.15 grams.

Weight, grams..... 14.00

Expressed in troy grains..... 216.05 grains.

Minting proportions:

Pure gold	54.64	} = 1,000 parts.
Pure silver	845.36	
Copper	100.00	

Value of the .85 centigrams of standard gold in the goloid dollar, in cents..... 50.841

Value of the 13.15 grams of standard silver in the goloid dollar, in cents..... 49.159

Cents..... 100.00

Multiples and divisions of the coin:

Two-dollar goloid coin	weight, 28 grams; value, \$2 00
Half-dollar goloid coin	weight, 7 grams; value, 50
Quarter-dollar goloid coin	weight, 3.5 grams; value, 25
One dime goloid coin	weight, 1.4 grams; value, 10

The metric goloid dollar is the real unit of value of "gold and silver," or of the precious metals, and of metric coinage; while the metric gold dollar of 1.75 grams would be the denominational unit of metric gold, and the metric silver dollar of 25 grams, hereafter specified, would be the denominational unit of metric silver.

The whole system of the precious metals consolidates itself on the goloid dollar as the real unit of value, possessing the compensating and controlling power of unity of use and valuation within itself, and drawing both the gold and the silver on the united standard, and ratio in practical mintage of 1 to 16, into itself, as their most valuable and useful embodiment; hence forcing and holding them to par, or 100 to 100. While as a metal it stands next to gold in density, and above either gold or silver in its sonority or ring, its colors differ from other alloys. Its toughness exceeds either gold or silver binary alloys. Its resistance to abrasion is in the aggregate fully equal to gold, and its convenience of size for its denominations of \$2, \$1, 50 and 25 cents, exceeds all other coin for American coinage. Its equation of value in weight, to metric gold stands as 8 is to 1.

3. METRIC SILVER DOLLARS; RATIO OF VALUE 1 TO 16.

Parts of alloy:

Pure gold 105 milligrams; pure silver 22.395 grams; copper 2.5 grams: total weight 25 grams.

Expressed in standard metals:

Standard gold	.117 milligrams, .9 fine.
Standard silver	24.833 grams, .9 fine.

Weight, grams..... 25.000
Expressed in troy grains..... = 385.8 grains.

Minting proportions:

Pure silver	895.8	} 1,000 parts.
Pure gold	4.2	
Copper	100.0	

Value of the .117 milligrams of standard gold..... 6.98 cents.

Value of the 24.833 grams of standard silver..... 93.02 cents.

Cents..... 100.00

Divisions of the coin:

One dollar (being the unit of denomination)	weight, 25 grams.
Half-dollar	weight, 12.5 grams; 50 cents.
Quarter-dollar	weight, 6.25 grams; 25 cents.
One dime	weight, 2.5 grams; 10 cents.

This metric silver dollar is of the precise weight (25 grams) of the French silver 5-franc piece, the value of which is 93.5 cents;

This American metric silver dollar would be smaller, more dense, of the same weight, 100 cents in value, in even decimals as well as metric, and would therefore tend to displace the Belgian 5 franc, the Bolivian dollar, the French 5 franc, the Italian 5 lira, the Spanish 5 peseta, the Swiss 5 franc silver coin, in the markets of the world; it being 6.5 cents more valuable. The "one-stella" gold coin would also circulate all over the world, because of its convenient denomination and metric measures, bearing simple relations to the gram. Exchanges would be settled in the fine bullion, \$100 ingots, gold with gold countries and silver with silver countries, until circumstances force them to adopt in full this metric system, as they will; or the rapid growth of this country will draw both the gold and silver from them to go into our metric coinage, where it will be most valuable, and our industries become so vast in surplus productions, that not only will there be employment for all, in the creation of permanent wealth and improvements in this country, but the exchanges of the world will be in our favor; and the monometallic gold countries of Europe, will have missed the possibility of making this country subordinate to their concentration of money power on gold alone, while America will have her metric gold and goloid coinage and ingots, backed by the richest gold and silver mines of the world, as her sure foundation of reliance for the stability of value of the works or productions of her industry. The weights of these coin

are expressed in both metric and in troy measures. This is an important feature in the formulation and discovery, that both the metric and troy systems come together, on this coinage basis, perfectly.

Prepared for the Committee on Coinage, Weights, and Measures, first session Forty-sixth Congress, by

WM. WHEELER HUBBELL,
Counsellor, Expert, Inventor & Patentee.

WASHINGTON, D. C., May 5, 1879.

EXHIBIT B.

Table of the *metric coin* stated both in troy grains and form and in the French metric gram and form of weights.

Metric gold coin.

Troy grains.	Grams.	Dollars.	Kind of coin.
540 ₈	35	20.00	one double eagle.
270 ₁₆	17.5	10.00	one eagle.
135 ₃₂	8.75	5.00	half eagle.
108 ₆₄	7	4.00	one stella.
67 ₃₂	4.375	2.50	quarter eagle.
27 ₁₆	1.75	1.00	one gold dollar.

Metric goloid coin.

432 ₁₀	28	2.00	two dollars goloid.
216 ₁₀	14	1.00	one goloid dollar.
108 ₁₀	7	0.50	half goloid dollar.
54 ₅	3.5	0.25	quarter goloid dollar.

Metric silver coin.

385 ₈	25	1.00	one silver dollar.
192 ₅	12.5	0.50	half silver dollar.
96 ₄	6.25	0.25	quarter silver dollar.
38 ₁₆	2.5	0.10	one silver dime.

WM. WHEELER HUBBELL,
Counsellor and Inventor.

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